Kurt Gödel

An exceptional mathematician
and an exceptional human being

William D. Brewer Fachbereich Physik, Freie Universität Berlin

Albert Einstein and Kurt Gödel, ca. 1948, when Gödel was formulating his solution to Einstein‘s field equations: ‘*Gödel‘s Universe*‘

Abstract:

Kurt Gödel is considered by many to be ‘the most important logician of the 20th century’. Nevertheless, he is not well known outside professional logic and philosophical circles.

In this talk, we start with a brief summary of his life and career, then consider in more detail his most important achievements in logic/fundamentals of mathematics and set theory, his early visits to the IAS/Princeton, and his lesser-known contributions to philosophy, cosmology, and computer science, as well as his friendship with Albert Einstein. We also consider some open questions about his biography, and in particular his relations with other mathematicians and philosophers. The talk concludes with some considerations about Gödel’s health, particularly his psychiatric problems, which led to his ‘personality disturbances’ and ultimately to his death.

This talk is based to some extent on the recent book ‘*Kurt Gödel – the Genius of Metamathematics’* (W.D. Brewer, Springer Scientific Biographies, 2022/23).

Topics:

- –I. Introduction. Gödel‘s early life and studies.
- –II. Mathematics in Vienna, 1930 – 1939.
  Completeness of 1st–order logic, Incompleteness, Set theory.
- –III. Gödel‘s Princeton stays, 1933-34, 1935, 1938-39.
- –IV. Gödel‘s move to Princeton, 1940. Set theory,
  Philosophy. Gödel‘s Universe. *Friendship with Einstein*.
- –V. Gödel‘s legacy and reception. Computability, Mind/
  Machine, Philosophy. *Open questions*.
- –VI. Gödel‘s *health, personality,* & *social problems*.
  “*Logik und Wahnsinn*“*.

*Cf. “*Logicomix*“, A. Doxiadis & C.H. Papadimitriou (2009). There is a popular idea that logic induces psychoses, or *vice versa*.

I. Introduction: Kurt Gödel‘s life and work.

Kurt Friedrich Gödel (1906-1978) was born in the city of *Brünn* (*Brno*/CZ), at the time of his birth a provincial capital in the Austro-Hungarian Empire. His father‘s family were upper middle class and long-term residents of Brünn, which was a ‘language island‘ (60% German, 40% Czech, surroundings Czech).

Gödel is best known among mathematicians, physicists and philosophers for his scientific work in logic and fundamentals of mathematics (Completeness of the predicate calculus, Incompleteness of axiomatic arithmetic, Set theory), General Relativity (‘Gödel’s Universe’), and philosophy. Hofstadter’s ‘*Gödel, Escher, Bach – an Eternal Golden Braid*’, published in 1979, made his name known to a wider public, but he remains somehow an enigmatic figure to this day, over 45 years after his death. Interesting questions are the origin of his *unusual personality*, which often caused difficulties in his daily life but may have aided his scientific work; his close *friendship with Albert Einstein*, a generation older and considerably different in personality; and his *philosophy*, of which he published little during his lifetime, but which has become a source of considerable discussion since his unpublished papers have become accessible.

Kurt Gödel, 1924

A brief academic biography

Kurt Gödel began his university studies in 1924 at the Philosophical Faculty of the University of Vienna. He initially concentrated on theoretical physics, but after two years changed his major to mathematics, with a strong interest in philosophy. He accepted *Hans Hahn* in 1926 as his mentor, and Hahn involved him in the discussions of the *Vienna Circle* (*Schlick* Circle). In 1927-29, he interacted extensively with *Rudolf Carnap*, at that time a postdoc at the UniVie, and with *Karl Menger*, a young professor of mathematics. He submitted his dissertation, on the *Completeness of the predicate calculus*, with the sponsorship of Hahn in Sept. 1929 and was granted the doctorate in early 1930.

Hans Hahn, ca. 1928

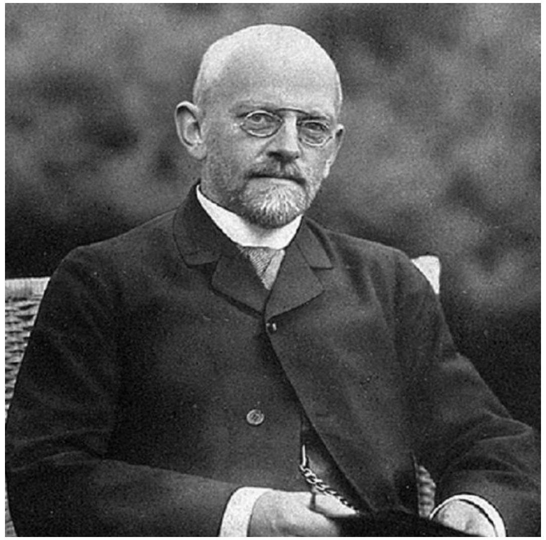
Moritz Schlick, 1927

Rudolf Carnap, ca. 1925

Karl Menger, 1928

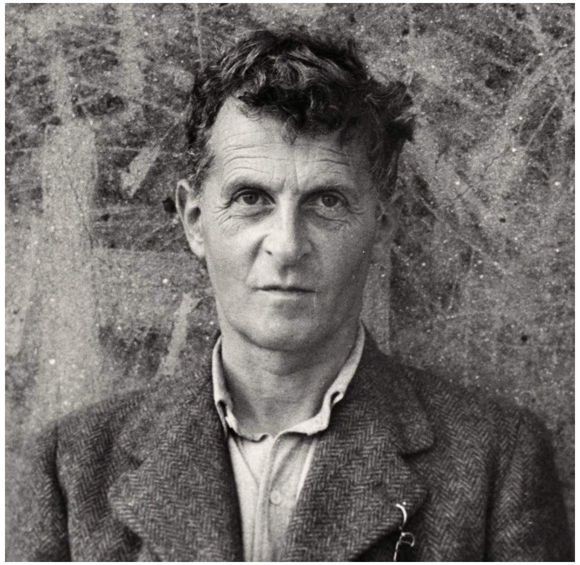
By that time, Gödel was already working on his *Incompleteness theorems*, which effectively upset the programs of the *formalists* (*Hilbert, Bernays, Ackermann, Gentzen*) and the *logicists* (*Frege, Russell, Whitehead*) by demonstrating that no formal logical system containing arithmetic could be both consistent and complete (in the sense that all derivable theorems could be proved or disproved within the system).

The influence and relationship of *Ludwig Wittgenstein* to Gödel's philosophy and mathematics during this period is unclear (Wittgenstein had a strong influence on the Vienna Circle, although not himself a member), and it is still a subject of controversy, as is his understanding of Gödel's work. See below…



David Hilbert, ca. 1920

Bertrand Russell, 1912



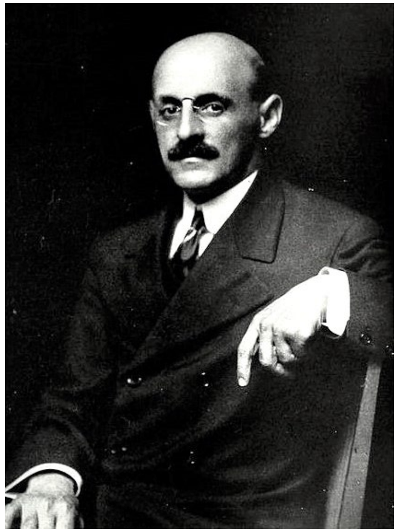
Ludwig Wittgenstein, 1925

After the publication of the Incompleteness theorems, Gödel obtained his *Habilitation* and began teaching as a *Privatdozent* in Vienna. He also started work on set theory, in particular the compatibility and independence of the Axiom of Choice (AC) and the Continuum Hypothesis (CH) from the axioms of Zermelo-Fraenkel-von Neumann set theory (ZF).

His reputation as an innovative logician was growing, and he was invited to spend the academic year 1933/34 at the newly- founded *Institute for Advanced Study* (IAS) in Princeton, USA. There, he gave his 'Princeton Lectures' which are a definitive source on Incompleteness, and also treated *general recursive functions*, later important (e.g. in defining *computability*).

Old Fine Hall, Princeton

Oswald Veblen, 1915



Abraham Flexner, 1910

On returning to Vienna in June 1934, Gödel suffered the first of a series of breakdowns, in which he was subject to severe depression and anxiety attacks. They were exacerbated by the unexpected death of his mentor *Hans Hahn* in July, and they led to Gödel's confinement in a sanatorium near Vienna in the autumn, and to the postponement of his planned second visit to the IAS in 1934. He initially recovered by November, and he was able to give his second course as *Privatdozent* during the spring of 1935, but he continued to have psychiatric problems.

Gödel returned to Princeton and the IAS in October 1935, but the sudden recurrence of his depression/anxiety syndrome in late November prompted his premature departure for Vienna by December. The following year, 1936, was a 'lost year' for Gödel, spent in sanatoria and therapy.

Sanatorium *Purkersdorf*, near Vienna

Sanatorium *Breitenstein am Semmering*

By early 1937, Kurt was finally recovering from his psychiatric difficulties and was able to give his next course, entitled *Axiomatik der Mengenlehre*, in the spring semester. One of his students in the course was *Andrzei Mostowski*, later a well-known mathematician. Kurt's friend *Karl Menger* had in the meantime emigrated to the USA and was teaching at *Notre Dame* University. Moritz Schlick had been assassinated in June 1936 by a deranged former student. This marked the end of both the *Wiener Kreis* and the *Mathematisches Kolloquium*, and many of Kurt's former colleagues had by now left Austria.

Gödel's position as *Privatdozent* was cancelled after the *Anschluss* of Austria by the German *Reich* in early 1938. He was however still able to travel again to Princeton in October, after marrying his long-term lady friend, *Adele Porkert*, in September of that year. He gave a series of lectures on his set-theory work at Princeton, then went to Notre Dame for the spring semester, where he gave two courses, invited by his friend Karl Menger. He returned to Vienna in June 1939, uncertain as to whether he would stay there or return to Princeton. Bad experiences with the Austrian authorities and public decided the question, and in January 1940, Kurt and Adele traveled via the Transsiberian Railway to Vladivostok, thence to Yokohama and finally to San Francisco, where they continued by train to Princeton − a journey of over two months. Gödel stayed on at the IAS, becoming a permanent member and later, in 1953, a professor there. He never again left the USA.

II. Completeness, Incompleteness, Set Theory

Gödel is best known for his work on fundamentals of mathematics. It was carried out mostly in Vienna:

−**1928-29**, for his doctoral dissertation: the

Completeness of the first-order predicate calculus.

First-order logic is applied to individuals, members of a *domain of individuals*. A formal logical system in first-order logic is expressed by a language $\mathcal{L}$ and may contain a set of axioms and rules of inference, specifying how new sentences are to be derived from the axioms. There are also relations between individuals, specified by operators or functions, and quantifiers, which limit the values that variables can take. The system is presumed to be *consistent*: no contradictions can be revealed by any finite chain of logical conclusions within the system.

Strictly speaking, we must distinguish between the *syntax* (‘proof theory’) of the formal system, i.e., the formal-logical rules which govern its language, relations, functions, and how proofs are carried out; and its *semantics* (‘model theory’), i.e., what the system *means* or represents. Gödel was one of the first to emphasize this distinction.

From Gödel’s dissertation (*Uni Wien*, 1929, unpublished):

“The principal object of the following investigation is the proof of the completeness of the axiomatic system of what is called the restricted functional calculus, as given in Russell and Whitehead, *Principia Mathematica*, and in a similar form in Hilbert and Ackermann’s *Principles of Mathematical Logic III*… Here, ‘completeness’ is taken to mean that every generally valid formula that can be expressed in the restricted functional calculus … can be deduced by means of a finite series of formal conclusions from the axioms. This assertion can readily be shown to be equivalent to the following: Every consistent axiomatic system which consists only of quantity statements has a realization (a *model*)”.

Memorial plaque at *Frankgasse 10, Wien 9*, where Gödel lived briefly in 1927.

The formula shown at the bottom of the memorial plaque at the entrance to *Frankgasse 10*: $\vdash A \Leftrightarrow \vDash A$, is a symbolic expression of the two concepts of *soundness* and *completeness*. Reading from left to right, this formula says that “a system $\mathcal{G}$ or language $\mathcal{L}$ (not specified) proves only sentences which are satisfied (valid)”—this is *soundness*— and reading from right to left, it says that “all valid sentences are proved by $\mathcal{L}$” — *completeness*. In words, it might be expressed as “$\mathcal{G}$ *proves* A iff $\mathcal{G}$ *models* A”. Gödel proved this version in his thesis (and a simplified proof was later provided by *Leon Henkin* (1949)).

Gödel, in his thesis, concerned himself with *predicate logic* (in Gödel's time, it was called '*the first-order predicate calculus*'). It was first introduced by the Boolean school, and later developed by Frege.

This was both a natural and successful choice, but also a limiting one: as Hintikka (1999) puts it:

"*Gödel's completeness proof for the ordinary first-order logic thus, in effect, served to reassure logicians and philosophers that they could happily go on practicing their proof-theoretical problems*... [But: his proof] *is therefore unrepresentative of the conceptual situation of logic in general. His Einsteinian question, the question concerning semantical completeness, was asked about a wrong logic*".

−**1930-31**, for his *Habilitation*, the

Incompleteness of formal systems for number theory:

In his next project, begun in the spring of 1930, Gödel took on the more general task of testing the completeness of (consistent) formal systems capable of expressing all of arithmetic. He considered a particular system containing the axioms for arithmetic as stated by Peano, combined with the logic from Russell and Whitehead‘s *Principia Mathematica*. He called it ‘*system P*‘, but his proof in fact includes *all* (consistent, formal) systems capable of expressing arithmetic. This was indeed Hilbert‘s *Second Problem* (1900).

The resulting proof is considered a masterpiece of logic and earned Gödel the distinction of being “the most important logician of the 20th century“. It is also rather complicated, and understanding its details is a project in itself. Only after Gödel‘s ‘Princeton Lectures‘ at the IAS in spring 1994, and the work of several younger logicians (*Stephen Kleene, J. Barkley Rosser*) did it begin to be generally understood.

Gödel introduced a *code*, a mapping of statements about natural numbers onto natural numbers themselves, called ‘Gödel numbering‘, and used it (in a self-referential way, but avoiding the usual paradoxes) to reduce proofs within the formal system to arithmetic formulas which could be manipulated and tested in a simple way.

The result was the conclusion that *no* consistent formal system capable of expressing arithmetic is *complete* − every such system will contain statements derivable from its axioms which can neither be proven nor disproven: they are *undecidable*, and the system is therefore incomplete, in Hilbert‘s sense (Gödel‘s 1st theorem).

He announced this result at a conference in Königsberg on September 7th, 1930. And no-one there, including Gödel‘s sometime mentor *Rudolf Carnap*, realized the significance of his announcement, except for *Johann* (‘Jonny‘) *von Neumann*, later one of ‘*The Martians*‘.

Gödel‘s (first) theorem, and his ‘second theorem‘, which addressed the question of *consistency*, the focal point of Hilbert‘s 2nd problem, effectively derailed the formalization projects of the *Logicists* (Frege, Russell, ...) and the *Formalists* (Hilbert, Bernays, Ackermann ...) and provoked a crisis in fundamental mathematics. This ‘second theorem‘, compactly stated, says that *no* consistent formal system capable of expressing arithmetic can prove its own consistency.

Both theorems have often been misquoted and misused, in particular over-generalized to be taken as widely-applicable statements about the limitations of knowledge *per se*. Gödel himself remained optimistic about the possibility of proving all of mathematics, and even philosophy, on the basis of purely logical arguments, long after publishing his two incompleteness theorems.

Gödel and Tarski on ***Truth***

An important aspect of Gödel's work on incompleteness was his exposition of *truth* in a formal-mathematical context. 'Truth' has many meanings, ranging from the trivial ('2 + 2 = 4 is true') to difficult and controversial philosophical concepts. Gödel determined (already in his letter to Ernst Zermelo in Oct. 1931) that 'truth' cannot be defined in a formal (syntactical, proof-theoretical) context (since it cannot be denoted e.g. by 'Gödel numbering'), but only in a semantic, model-theoretical context. This was later independently formulated by Alfred Tarski, and it is now often called the 'Gödel-Tarski Truth theorem'. See Floyd (2001) and Koreň (2011).

Figure: Alfred Tarski and Kurt Gödel in Vienna, 1935.

−**1935-39**, the

Compatibility of the Axiom of Choice (AC) and the Continuum Hypothesis (CH) with the axioms of Zermelo-Fraenkel (ZF) set theory.

In the spring of 1935, Gödel began working on several aspects of set theory, about which he had apparently been thinking for some time. He started with the axiomatized version of Georg Cantor‘s set theory, due to Zermelo, Fraenkel, and von Neumann (ZF set theory), and set out to prove the consistency (w.r.t. the other axioms) of two new axioms: the axiom of choice (AC), and Cantor‘s continuum hypothesis (CH). As a second step, he planned to show that those two axioms were <u>independent</u> of the other ZF axioms; i.e. with the ZF axioms, they could be proven, but also their *converses* could be proven (or both not proven).

He had early success proving the consistency of the AC, and reportedly cried out, “*Jetzt, Mengenlehre*!“ (in the style of “Eureka!“) in June 1935, when he obtained that result. The CH was more difficult. It had been proposed by Cantor, and proving it was Hilbert‘s 1st problem. Gödel was, after several years, able to show that it was compatible with ZF + AC, but proving its independence was not possible with the methods that he was using. That was finally accomplished by a younger colleague, Paul Cohen, in 1963 (with Gödel‘s encouragement). Gödel published several articles and gave various courses on his set theory work, which continued up to around 1943.

III. Visits to Princeton

Gödel was invited to Princeton in 1933 by *Abraham Flexner*, director of the IAS, on the recommendation of *Oswald Veblen*, with input from *Karl Menger* and *John von Neumann*.

His first stay, from Oct. 1933 to June 1934, was very successful. In the spring of 1934, he gave a series of lectures (‘the Princeton Lectures‘) explaining and deepening his Incompleteness results, which remained a classic for many years.

His second stay, planned for Oct. 1934, had to be postponed due to his illness. He eventually traveled to Princeton a year later, but after only 6 weeks, his depression and anxiety attacks recurred, so that he had to return to Vienna, in a poor state. He was finally able to return to Princeton for his third stay in October-December of 1938. He had married Adele Porkert in September 1938, and departed (alone) for Princeton just over a week later, returning to Vienna in June, 1939 (a strange sort of honeymoon!).

In Princeton, he gave another series of lectures, on his set theory work, and prepared his first publication on that work, as well as a summary paper (1940), based on the lectures. In early 1939, he went to Notre Dame University, where his friend and mentor *Karl Menger* had in the meantime obtained a professorship.

IV. Gödel in Princeton

In his first years at the IAS, Gödel continued working on the independence of the AC and the CH from the axioms of ZF set theory. But his interests gradually shifted toward *philosophy*. In 1946, he started working on a new solution to Einstein‘s field equations for gravity, motivated by the comparison of the GRT interpretation of *time* as compared to Kant‘s ideas. This led him to ‘Gödel‘s Universe‘, a rotating world with closed-loop, timelike worldlines. He published the results in an Einstein *Festschrift* in 1949, and in *Rev. Mod. Phys*. that same year.

The Gödels‘ house on Linden Lane
In Princeton, purchased 1947.

Fuld Hall, the main building of the IAS, opened October 1939.

In the first seven years after arriving in Princeton in March 1940, Gödel had only annual contracts. He was finally made a permanent member in 1946, after interventions by Veblen and von Neumann. Only after another 7 years was he promoted to professor.

Soon after his arrival at the IAS, Gödel made <u>two new friends</u>, who remained loyal to the ends of their lives, and were among the rather few real friends whom he had in his lifetime. One was *Oskar Morgenstern*, who had emigrated from Vienna. He and Gödel had been acquaintances in Vienna, but only in Princeton did they become real friends. Their friendship continued until Morgenstern's death in July 1977.

His other close friend in Princeton was *Albert Einstein*, a founding member of the IAS. They had met during Gödel's first visit in 1933/34, but only around 1942 did they become close friends, walking together every day to and from the Institute from their respective homes. A philosopher/chemist, *Paul Oppenheim*, who had known Einstein in Germany, arrived in Princeton in 1939 and renewed his friendship with Einstein. He claims credit for (re-)introducing him to Gödel, around mid-1940. Einstein remained a close friend of Gödel's until his death in 1955.

The origins of the Gödel-Einstein friendship are somewhat mysterious. They were a generation apart, had rather different fields of interest, and quite different public personalities.

The Gödel-Einstein Friendship.

What brought Gödel and Einstein together? In my opinion, it was three things: *First*, by 1942 they had both worked for a number of years on their respective projects, Gödel on the independence of the Continuum Hypothesis, Einstein on a Unified Field theory; and both were uncertain of finding a suitable conclusion to their work. *Second*, their language: both were from the southern part of the German-speaking world, and they had similar dialects (sub-dialects of *Mittelbairisch*). *Third*, for both, scientific work was an escape from the banality of everyday life, and they could lose themselves in details of their current scientific problems. Each had little love for worldly values.

Gödel‘s *Philosophy.*

In Princeton, Gödel at first continued his work on set theory, and gave several lectures at the IAS and at nearby universities on that topic. But he was increasingly frustrated with his failure to prove the indpendence of the CH. In November 1942, *Paul Arthur Schilpp*, the editor of the ‘Contemporary Philosophers‘ book series, asked Gödel to contribute a chapter to a volume on Bertrand Russell. It was published in 1944, and Gödel‘s chapter was entitled “*Russell‘s Mathematical Logic*“. It was Gödel‘s first publication of a philosophical nature, although he had read many works of various philosophers, especially Plato, Kant, and Leibniz, in previous years.

A review of Gödel‘s chapter by Paul Bernays makes the following remarks:
“Gödel, discussing, with some criticism, the leading ideas of *Principia Mathematica*, treats mainly of the devices which were chosen by Russell as a means of overcoming the difficulties connected with the logical paradoxes… Gödel points especially to the circumstance that it is just Russell’s refraining from a more decided realism towards the logical and mathematical objects, to which are due the known difficulties in *Principia Mathematica*. All these difficulties, he argues, can be avoided by admitting that classes and concepts may be conceived as real objects, classes as structures consisting of a plurality of things, and concepts as the properties and relations of things *existing independently of our definitions and constructions*”.

This last (italic) phrase is typical of Gödel‘s ‘Platonism‘, which leads him to assume that concepts in mathematics are intrinsic to the world, and are to be *discovered* by ‘mathematical intuition‘, and not developed or constructed by mathematicians (see [Parsons (1995)] and [Hintikka (2005)]).

After being attracted by *Platonism* during his student days in Vienna, Gödel took a strong interest in the writings of *Gottfried Wilhelm Leibniz* (1646-1716), whom he saw as prescient in many areas of mathematics and computer science. Gödel read Leibniz‘s works for around 20 years, from the mid-1930‘s to about 1954.

In 1959, he developed a fascination for the later writings of *Edmund Husserl* (1859-1938), an early proponent of *phenomenology*, who had experienced a kind of ‘epiphany‘ around 1909, shortly before he moved to the University of Freiburg, where he spent the rest of his career. One can find a number of parallels between the scientific careers of Husserl and Gödel, although their personalities were doubtless very different. The philosopher *Dagfinn Føllesdal* (1995) quotes Gödel on *phenomenology*: "Gödel describes Husserl's method as '*focusing more sharply on the concepts concerned by directing our attention … onto our own acts in the use of these concepts, onto our powers in carrying out our acts, etc*'." Van Atten and Kennedy (2003) term Gödel's approach "*phenomenology as a systematic means to combine the two strands of thought he had adopted earlier, his strong realist view of mathematics and the Leibnizian framework that put subjectivity in central position (monadology)*."

V. Gödel‘s Legacy and Reception.

Computability, Mind/Machine, Philosophy. Open Questions.

At the time of his death in early 1978, Kurt Gödel was practically unknown to the larger public, and even within the mathematics community, he was well-known only to logicians and those few who worked in fundamentals of mathematics. Even his family in Vienna had not been aware of his achievements until around 1947, when his friend Oskar Morgenstern visited them.

All that changed with the publication of Douglas Hofstadter‘s iconic book, ‘*Gödel, Escher, Bach − an Eternal Golden Braid*‘ (GEB), in 1979. Hofstadter‘s goal was to explain his ideas about *strange loops*, his term for self-referential cyclic processes, which he believed to be important for the functioning of the human mind and perhaps the genesis of consciousness. His book was evidently inspired by his early reading of *Gödel‘s Proof*, a 1958 book by *Ernest Nagel* and *James R. Newman*, based on their article in *Scientific American* two years earlier. Hofstadter‘s GEB, in turn, was widely circulated and made Gödel‘s name known to the general public for the first time. Ironically, it appeared just a year after Gödel‘s death.

The question of ‘computability’ was already raised in 1928 as one of Hilbert’s Problems; he called it ‘*das Entscheidungsproblem*’, referring to the question of whether a decision as to the validity of a given formal-logical statement could be reached ‘mechanically’ (cf. Hilbert & Ackermann (1928)).

Kurt Gödel and his logician colleague at Princeton University, *Alonzo Church*, both took up the question of how to define ‘computability‘ around 1934. Church had developed a formal system which he called the ‘λ-calculus‘, and he proposed that expressions satisfying it could be considered ‘computable‘. Gödel at first disagreed, and suggested his own definition, based on ‘general recursive functions‘, an idea that he had through correspondence with *Jacques Herbrand*.

Alan Turing, a young English logician and mathematician, arrived at his own definition, based on his ‘Turing machine‘, and *Emil Post*, a Polish-American logician, came up with similar conclusions. All of them turned out to be equivalent, and Gödel later said that he preferred Turing‘s formulation, since it was intuitively clearest. Because of this work, and his early recognition of ‘speed-up theorems‘, Gödel is considered to be one of the founders of modern theoretical computer science. See the book edited by [Copeland, Posy and Shagrir (2013)] (‘CPS‘): ‘*Computability: Turing, Gödel, Church and Beyond*‘.

A related problem is the possibility of building an 'intelligent machine', one which can duplicate human thought processes. Turing inclined to the view that this would someday be possible, but Gödel was skeptical. Other scholars have maintained that Gödel's Incompleteness theorem rules out that possibility forever; see e.g. [Lucas (1961)], and [Penrose (1989), (1995)]. Nagel & Newman also inclined to that view, although Gödel himself denied it.

A similar question is that of understanding the human mind and consciousness based on a 'mechanical' (physicalist, materialist) model. Gödel himself did not deal with this problem, but given his Platonism, he would probably have rejected it.

Gödel's philosophy also included what he called the 'theological worldview': A belief in some sort of afterlife, or a 'second world'. He formulated, but failed to publish, a formalized proof of the existence of God (which he himself claimed was only an exercise in formal logic). It has been shown to be syntactically correct. See Adams (1995) and Benzmüller & Paleo (2014).

Open Questions

Although Gödel died in early 1978, already 46 years ago, many aspects of his legacy are still controversial, and not all of the many papers he left behind have been transcribed or evaluated. (This is complicated by the fact that he wrote most of them in the *Gabelsberger Schnellschrift*, a now obsolete form of shorthand which few people today can read).

There is in the meantime a considerable secondary literature on various aspects of these open questions: for example, what was Gödel‘s relationship to *Ludwig Wittgenstein*, and how much of Gödel‘s work did Wittgenstein understand (in the sense meant by Gödel)?

And how much did his early work owe to *Bertrand Russell*, and to *Rudolf Carnap*?

What was the role of *Leibniz*‘s writings in the development of Gödel‘s logic and his philosophy?

How did this change after he began reading the later works of *Husserl* in 1959-1977?

All of these questions are discussed controversially in the literature (see the References at the end of this lecture).

VI. Gödel’s Health, Personality, and Social Problems.

Gödel‘s lifelong health problems began when he was 4 or 5 years old. He suffered from an anxiety neurosis and was unusually attached to his mother, crying at length whenever she left their apartment. His parents apparently dismissed that as ‘only a phase‘, and it indeed passed after some time. At the age of 8, he had a bout of rheumatic fever, probably caused by a *streptococcus* infection, and missed several months of school. Although he recovered completely, according to his doctors, he continued to believe that he had heart damage from the infection, and that was the beginning of his lifelong hypochondria and mistrust of doctors and medicine.

The years between 1915 and 1933 were probably the most healthy, both mentally and physically, in his whole life. In those years, he finished school (in 1924), studied first physics, then mathematics in Vienna, obtained his doctorate (in 1930), published his two most important papers, and completed his *Habilitation* (in early 1933). He became a *Privatdozent*, carried out independent research and teaching, and made his first trip to Princeton (Oct. 1933-June 1934).

However, shortly after his return to Vienna in June 1934, Gödel suffered a breakdown and showed symptoms of depression and anxiety syndrome. The stress of his trip abroad and the difficult political situation in Austria, and then the unexpected death of his mentor *Hans Hahn* in July, only worsened his condition, and he had to be hospitalized in October 1934.

While Gödel recovered from his breakdowns in 1934 and 1935, he suffered a recurrence during his stay in the USA in November 1935, and was practically incapacitated until early 1937. Thereafter, he never again required a longer hospitalization, but his symptoms − increasing hypochondria, accompanied by general paranoia − recurred throughout the rest of his life, becoming gradually more serious as he grew older, and led to several crises in the years 1951-75. His health problems caused much concern to the administration of the IAS, and led to his only very slowly being given a permanent position and finally a professorship there.

With the help of his loyal wife Adele, Gödel was able to overcome his personality problems to a large extent. At his worst, she had to test his food and even feed him by hand, since he was afraid of being poisoned by spoiled food (or intentionally!).

This problem diminished after their move to the USA, although he still feared poisoning by gases from the heating system or from their household refrigerator. But as he grew older, his paranoia again worsened, and it recurred more often. Finally, as Adele (who was 6-1/2 years older) began to have serious health problems of her own, Gödel was left to his own devices, and eventually died of self-imposed starvation, out of an irrational fear of poisoning, in early 1978, at age 71.

The ‘*most rational man*‘ (A. Church) committed involuntary suicide due to irrational fears!

Of course, it is impossible to make a certain diagnosis of Kurt Gödel‘s psychiatric problems in retrospect. One can only speculate; but given his life history, it seems possible and even probable that he was somewhere on the *autistic spectrum*, evidently near its ‘high performance‘ end. His primary symptoms, and his ‘co-morbidities‘, fit well with what was formerly called ‘*Asperger‘s Syndrome‘*. The same can be said of many persons who were dedicated scientists, and both Isaac Newton and Albert Einstein have been ‘posthumously diagnosed‘ as potential Asperger patients.

Hans Asperger himself, who called the syndrome ‘*autistic psychopathy*‘, referred to it as, “*an extreme variant of male intelligence*”. He believed, from his observations in Vienna in the later 1930‘s and early ‘40‘s, that it occurred only in boys, and was often accompanied by an extreme intelligence (mainly in a specific field). Those conclusions have been revised in the meantime, and Asperger‘s name has been removed from the syndrome (for the formal reason that it is part of the *Autistic Spectrum* and needs no special name; and for the historical reason that Asperger, in contrast to what he claimed after 1945, apparently cooperated with the Nazi authorities in giving up children from his clinic to their euthanasia programs).

But as *Lyons and Fitzgerald* (2004/05) said regarding Gödel‘s personality disturbances, “*Despite the difficulties associated with his condition, Kurt Gödel was able to use his enormous mathematical talents to achieve major scientific successes with the help of a few friends and the total dedication of his wife Adele*.“

References

Adams 1995: Robert M. Adams, ‘*Introduction to* [Gödel (*1970)]’, in the *Collected Works*, Vol. III (1995), 388–402.

Bays 2004: Timothy Bays, ‘*On Floyd and Putnam on Wittgenstein on Gödel*‘, *J. Phil*. CI.4 (April 2004), 197-210.

Benzmüller & Paleo 2014: Christoph Benzmuller and Bruno Woltzenlogel Paleo, ‘*Automating Godel’s Ontological Proof of God’s Existence with Higher-order Automated Theorem Provers*‘, ECAI (2014), 93-98. Open Access by IOS Press.

Bernays 1946: Paul Bernays, Review of ‘*Russell‘s Mathematical Logic*‘, by K. Gödel. *J. Symb. Logic* 11 (3) (1946), 75-79.

Brewer 2022: William D. Brewer, ‘*Kurt Gödel − The Genius of Metamathematics*‘, Springer/Nature (Sept. 2022). ISBN 978-3-031113-08-6.

Bromand 2018: Joachim Bromand, ‘*Wittgensteins Philosophie der Mathematik und Gödels Theorem*‘, in: *Beiträge zum Mathematikunterricht*, hrsg. v. der *Fachgruppe Didaktik der Mathematik* der Universität Paderborn, Münster: WTM-Verlag (2018), 353-356.

Copeland, Posy & Shagrir 2013: Copeland, B.J., Posy, C.J., Shagrir, O. (eds.): ‘*Computability: Turing, Gödel, Church and Beyond*‘. MIT Press, Cambridge MA (2013). ISBN 978-0-262018-99-3.

Crocco 2003: Gabriella Crocco, ‘*Gödel, Carnap and the Fregean Heritage*‘, in: *Synthese* 137 (2003), 21-41.

− 2013: Gabriella Crocco, ‘*Gödel, Leibniz and ”Russell’s mathematical logic”*’, in Ralf Kromer, Yannick Chin-Drian, eds., ‘*New essays in Leibniz reception*’, in *Science and Philosophy of Science* 1800-2000. Birkhäuser-Springer Science (2013), 217-256. ISBN 978-3-034605-03-8.

Floyd & Putnam 2000: Juliet Floyd and Hilary Putnam, ‘*A Note on Wittgenstein‘s “Notorious Paragraph“ about the Gödel Theorem*‘, *J. Phil*. 97 (11) (Nov. 2000), 624-632.

− 2001: Juliet Floyd, ‘*Prose vs. Proof: Wittgenstein on Gödel, Tarski and Truth*‘, *Phil. Math*. 9 (3) (2001), 280-307.

Floyd & Kanamori 2016: Floyd, J. and Kanamori, A., ‘*Gödel vis-à-vis Russell: Logic and Set Theory to Philosophy*’, in: *Gabriella Crocco and Eva-Maria Engelen, eds. ‘Kurt Gödel: Philosopher-Scientist’,* Aix en Provence: Presses Universitaires de Provence (2016).

Føllesdal (1995): Dagfinn Føllesdal, ‘*Introductory Note to Gödel* (*1961/?)‘, in the *Collected Works of Kurt Gödel*, Vol. III (1995), 364-373.

Gödel 1987 (Wang 87): Conversation between K. Gödel and H. Wang, quoted in Hau Wang, ‘*Reflections on Kurt Gödel*’, MIT Press (1987), pp. 178-180. ISBN 978-0-262231-27-5.

Henkin 1949: Henkin, Leon A.: ‘*The completeness of the first-order functional Calculus*’. In: *J. Symb. Logic* 14 (3), (1949), 159–166.

Hilbert & Ackermann 1928: Hilbert, D., Ackermann, W.: ‘*Grundzüge der theoretischen Logik*‘. Springer, Heidelberg/ Berlin (1928). Reissued 1959. English translation available.

Hintikka 2005: Hintikka, J.: ‘*What Platonism*? *Reflections on the thought of Kurt Gödel*’. In: *Revue internationale de philosophie* 234 (2005/4), 535–552.

Kahn 2014: Ilyas Kahn, ‘*Wittgenstein’s Characterisation of the Inconsistency within Mathematics*‘, online at: https://www.jbs.cam.ac.uk/wp-content/uploads/2020/08/2014-khan-wittgensteininconsistencymathematics.pdf.

Kennedy 2020: J.C. Kennedy, ‘*Gödel, Tarski, and the Lure of Natural Language*’. Cambridge University Press (2020). ISBN: 978-0-511998-39-3

Koreň 2011: Ladislav Koreň, ’*Semantic Conception of Truth…*’, online at: https://www.academia.edu/1410755/Semantic_Conception_of_Truth_What_It_Is_and_What_It_Is_Not.
Koshy 2016: Jacob Koshy, ‘*Should “post-truth“ depress us?*‘, in: *The Hindu*, Nov. 20, 2016. Online at https://www.thehindu.com/books/Should-‘post-truth’-depress-us/article16659688.ece
Kreisel 1998: Georg Kreisel, ‘*Second Thoughts around Some of Gödel's Writings*: "*A Non-Academic Option*“’, in: *Synthese*, 114 (1) (Jan. 1998), 99-160. See also: G. Kreisel, Review of ”*Wittgenstein’s Remarks on the Foundations of Mathematics* (1956)”, in: *The British Journal for the Philosophy of Science*, 9 (34), (Aug. 1958), 135-158; and G. Kreisel, Review of “*The Blue and Brown Books by Ludwig Wittgenstein: Remarks on the Foundations of Mathematics*”, in: *The British Journal for the Philosophy of Science* 11 (43) (Nov. 1960), 238-251.
Lampert 2006: Timm Lampert, ‘*Wittgenstein’s ‘notorious paragraph’ about the Gödel Theorem*`, in: *Contributions of the Austrian Wittgenstein Society* (2006), 168-171. See PhilArchive, https://philarchive.org/rec/LAMWNP.
Link 2009: Montgomery Link, ‘*Wittgenstein and Logic*‘, *Synthese* 166 (2009), 41-54.
− 2023: Montgomery Link, ‘*Conversations between Gödel and Wang on the* Tractatus’, in: Pichler, Alois; Heinrich-Ramharter, Esther; Stadler, Friedrich (eds.): Contributions/Beiträge to International Wittgenstein Symposium 2023: “*100 Years of Tractatus Logico-Philosophicus—70 Years after Wittgenstein’s Death. A Critical Assessment*” 6.-12. Aug. 2023, Kirchberg am Wechsel (2023).
Lucas 1961: Lucas, J.R., ‘*Minds, Machines, and Gödel*’. In: *Philosophy*, Vol. XXXVI (1961), pp. 112–127.
Nagel & Newman 1958: Nagel, E., Newman, J.R., ‘*Gödel’s Proof*’. NYU Press (2001) (Originally published in 1958. Reissued 2001, 2005, 2008). ISBN 978-0-814758-16-8. See also Nagel, E., Newman, J.R., ‘*Gödel’s Proof*’. In: *Scientific American* 194 (6) (1956), 71–90.

Odifreddi 2011: P. Odifreddi, ‘*Gödel’s Mathematics of Philosophy*‘, in: Baaz, M., Papadimitriou, C.H., Putnam, H.W., Scott, D.S., Harper, C.L., Jr. (eds.), *Kurt Gödel and the Foundations of Mathematics*. Cambridge University Press (2011). ISBN: 978-0-511974-23-6.

Parsons 1995: Parsons, C., ‘*Platonism and Mathematical Intuition in Kurt Gödel’s Thought*’, in: *Bull. Symb. Logic* 1 (1), (1995), 44–74.

Penrose 1989: Roger Penrose, ‘*The Emperor’s New Mind*’, Oxford University Press, 1989. ISBN 978-0-198519-73-7.

‒ 1995: Roger Penrose, ‘*Shadows of the Mind*’, Vintage Books, 1995. ISBN 978-0-099582-11-3.

Rodych 1997: Victor Rodych, ‘*Wittgenstein on Mathematical Meaningfulness, Decidability, and Application*‘, in *Notre Dame Journal of Formal Logic*, 38 (2) (1997), 195-225.

‒ 1999: Victor Rodych, ‘*Wittgenstein‘s Inversion of Gödel‘s Theorem*‘, in *Erkenntnis* 51 (1999), 173-206.

‒ 2003: Victor Rodych, ‘*Misunderstanding Gödel: New Arguments about Wittgenstein and New Remarks by Wittgenstein*‘, in: *Dialectica* 57 (3) (2003), 279-313.

Steiner 2001: Mark Steiner, ‘*Wittgenstein as His Own Worst Enemy: The Case of Gödel‘s Theorem*‘, in: *Phil. Math*. 9 (3) (2001), 257-279.

Tieszen 1998: Richard Tieszen, Review of ‘*Gödel's Philosophical Remarks on Logic and Mathematics* (*Collected Works*, Vols. I ‒ III, 1986‒1995)’, in: *Mind*, 107 (425) (Jan. 1998), 219-232.

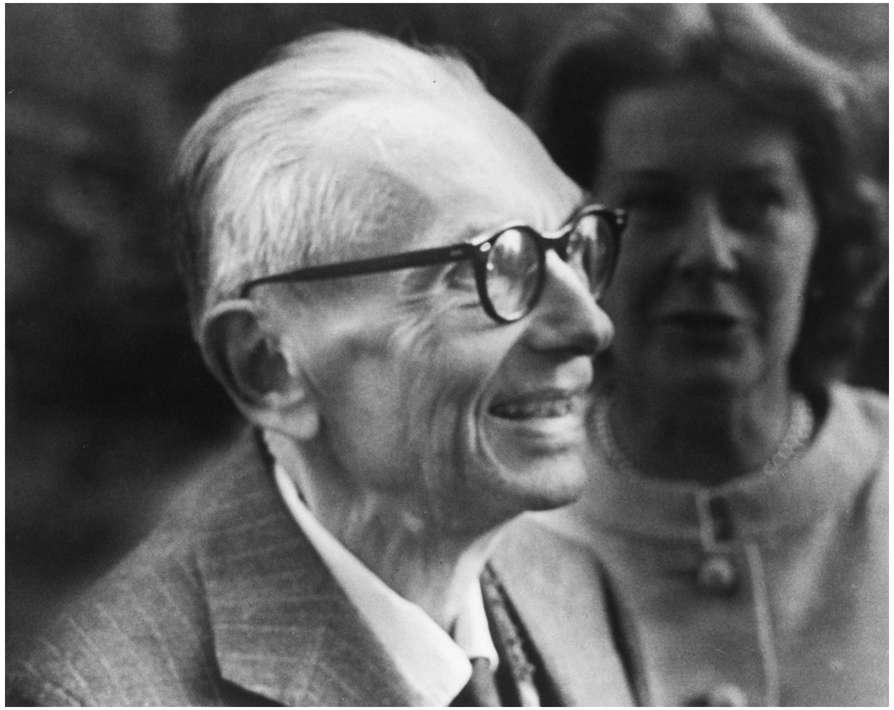
‒ 2011: Richard Tieszen, ‘*After Gödel: Platonism and Rationalism in Mathematics and Logic*‘, Oxford University Press, 2011. ISBN 978-0-199606-20-7.

van Atten & Kennedy 2003: van Atten, M., Kennedy, J.: ‘*On the philosophical development of Kurt Gödel*’, in: *Bull. of Symb. Logic* 9 (4) (2003), 425–476.

van Atten 2015: Mark van Atten, ‘*Preface and introduction to “Essays on Gödel’s Reception of Leibniz, Husserl, and Brouwer*”’, Springer, Dordrecht (2015). ISBN 978-3-319100-30-2.

Conclusions.

Kurt Gödel was a most unusual human being. He had a powerful ‘mathematical intuition‘ and a very logical mind, and was exceptional in that respect. But at the same time, he showed symptoms of a serious personality disturbance, and may well have been on the ‘autustic spectrum‘ (Asperger‘s Syndrome). His mathematical achievements make him a candidate for ‘most important logician of the 20th century‘, but he has remained obscure to much of the public. His philosophical contributions are still controversial. But he has a well-deserved place in the history of mathematics and of philosophy.



Kurt Gödel and Dorothy Morgenstern at the IAS garden party, Oct. 7th, 1973. A happy moment near the end of his life.

And to the audience:
Thank you for your attention!