Journal for General Philosophy of Science (2019) 50:409–427
https://doi.org/10.1007/s10838-019-09489-z

OBITUARY

Inquiring into Space-Time, the Human Mind, and Religion: The Life and Work of Adolf Grünbaum (1923–2018)

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Published online: 2 December 2019

(Photo courtesy: Barbara Grunbaum)

*15.05.1923 †15.11.2018

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Abstract
Grünbaum's three chief fields of research were space-time philosophy, the methodological credentials of psychoanalysis, and reasons given in favor of the existence of God. Grünbaum defended the so-called conventionality thesis of physical geometry. He partially followed Hans Reichenbach in this respect but developed a new ontological argument for the conventionality claim in addition. In addressing the physical basis of the direction of time, Grünbaum advocated that there is a physical basis for the distinction between the past and the future (or the anisotropy of time), but no such basis for the idea of a 'present' moving through time. His main claim in scrutinizing Freud's theory methodologically was that supporting the causal claims Freud made would have required data that go beyond the clinical setting. Finally, Grünbaum worked on the philosophy of religion and set out to undermine arguments for the existence of God.

Keywords Adolf Grünbaum · Space-time philosophy · Conventionalism · Being and becoming · Psychoanalysis · Sigmund Freud · Theism

1 Adolf Grünbaum: A Twentieth-Century Biography

Adolf Grünbaum was born in Cologne, Germany, on May 15, 1923, and died in Pittsburgh, Pennsylvania, on November 15, 2018. He has been one of the leading figures in twentieth-century philosophy of science. Grünbaum's Jewish family managed to escape the Nazi terror and came to the US in 1938. He went to high school in New York City and moved to Wesleyan College to study mathematics, physics, and philosophy. Grünbaum became a US citizen in 1944 and still served in World War II, first in a military research unit and afterward in occupation service interrogating German academic prisoners. Grünbaum did his graduate work at Yale with a dissertation on space-time philosophy. In 1950, he got his first academic appointment at Lehigh University in Bethlehem, PA. Ten years later he moved to the University of Pittsburgh to become the Andrew-Mellon Professor in Philosophy. In Pittsburgh, he established the then new Center for Philosophy of Science, rebuilt the Department of Philosophy, and was involved in founding the Department of History and Philosophy of Science (Grünbaum 2009, 56). The Center has evolved into one of the focal areas of philosophy of science around the globe. It enables external scholars to stay in Pittsburgh for up to a year and has thereby contributed to the pursuit and completion of an immense number of philosophical projects. It has also catalyzed innumerable highly productive philosophical exchanges, not only among the fellows, but also between fellows and Pitt faculty. In the past 60 years, the Pittsburgh Center has grown into a hotspot of international philosophical debate and interaction. Moreover, the early appointments made by Grünbaum (among them Nicholas Rescher and Larry Laudan (Grünbaum 2009, 56)) proved to be highly fruitful and started to transform the Departments of Philosophy and History and Philosophy of Science into leading institutions of philosophical research and teaching in the world.

Grünbaum was highly honored by the philosophical community. He served several times as President of the American Philosophical Association (Eastern Division) and the Philosophy of Science Association and was a member of many high-ranking Academies. Among other awards, he received the Humboldt Research Award in 1985 and honorary doctorates from the universities of Konstanz and Cologne. In 1989, he was conferred the "Master Scholar and Professor Award" from the University of Pittsburgh. Grünbaum was celebrated by no less than three *Festschrift* volumes, *Physics, Philosophy and Psychoanalysis: Essays in Honor of Adolf Grünbaum* (1983), *Philosophical Problems of the Internal and External Worlds: Essays on the Philosophy of Adolf Grünbaum* (1993), and *Philosophy of Religion, Physics, and Psychology: Essays in Honor of Adolf Grünbaum* (2005). He is certainly among the most highly decorated philosophers of all time.

Grünbaum left his footprints in various branches of philosophy of science. His three chief fields of research were space-time philosophy, the methodological credentials of psychoanalysis, and reasons given in favor of the existence of God. More specifically, he was concerned with the ways of establishing the evidential basis and the ontology of space-time theories. In this respect, Grünbaum was one of the most ardent defenders of the so-called conventionality thesis of physical geometry. He partially followed Hans Reichenbach in this respect but developed a new ontological argument for the conventionality claim in addition. Moreover, he addressed the physical basis of the direction of time. Grünbaum advocated that there is a physical basis for the distinction between the past and the future (or the anisotropy of time), but no such basis for the idea of a 'present' moving through time. The latter idea is purely psychological. His main claim in scrutinizing Freud's theory methodologically was that supporting the causal claims Freud made would have required data that go beyond the clinical setting. Psychoanalysis, as Grünbaum claims, cannot be confirmed by evidence 'from the couch' alone. Finally, Grünbaum immersed into the philosophy of religion and set out to undermine arguments for the existence of God.

2 Grünbaum on Exploring Spatiotemporal Relations

Since Hermann von Helmholtz (taking up clues from Carl Friedrich Gauß and Bernhard Riemann) had introduced the conceptual distinction between mathematical geometry, as abstract systems of spatial relations, and physical geometry, as the system of spatial relations that obtains in actual space, the question emerged as to how to establish physical geometry empirically. How can length measurements with rods or the determination of angles by using light rays ascertain whether physical geometry is Euclidean or flat or whether it is constantly or even variably curved? The latter systems had been envisaged as a mathematical possibility by Riemann in 1854. Helmholtz highlighted the free mobility of rigid rods as the crucial fact for determining the nature of physical space. We find that such rods can be transported without deformation through space. In other words, it is a fact of observation that the congruence of spatial figures is independent of place, direction, and path of transportation. This supposed fact restricts the leeway left to physical geometry to systems of constant curvature (spherical, saddle-like or flat) (Carrier 1994a).

The proponents of the Vienna Circle, in particular, Moritz Schlick, Rudolf Carnap, and Hans Reichenbach (taking clues from Henri Poincaré), disputed Helmholtz's tenet that physical geometry can be singled out by registering facts of nature. They rather argued that the observation of spatiotemporal relations left room for adjusting the system of physical geometry. The latter is underdetermined by experience, and this room is filled by conventional choice. Reichenbach's variant of the claim has become the standard version, and Grünbaum relied on this version for his own argument.

Reichenbach introduced the distinction between differential and universal forces. The former act differently on bodies of different material composition, while the latter act on all materials alike. The deformation of measuring rods produced by differential forces varies with the material of the rod and is thus easily detectable. Temperature is a case in point and the recipe for dealing with such forces is to correct their influence on measuring rods. By contrast, universal forces do not induce such material-specific effects and thus their presence and intensity escape observation in many cases. However, if the universal-force field is inhomogeneous (i.e., if its strength is position-dependent), it can produce relative deformations in suitably arranged rods. Hence a gradient of the force-field is empirically accessible; universal forces are not always coincidence-preserving.

Reichenbach argued that circularity lurks in detecting and evaluating universal forces. The measurement of spatial relations requires data from undistorted rods. But the only means to ascertain that rods are undistorted is to compare the measuring results obtained with the actual geometric relations. Yet, such a comparison could only be performed if the actual geometry was already known. Thus, a reciprocal dependence obtains between the universal force and physical geometry. This reciprocal dependence issues in a correction circularity in which the raw data measured with rods need to be rectified by factoring in a possible universal force. This procedure can only be accomplished by evaluating the difference between the measured spatial relations and the true ones. But these true relations are intended to be revealed by this approach in the first place. Reichenbach's recommendation amounts to dissolving this correction circularity by the conventional decision not to correct at all.

Reichenbach's suggestion for handling universal forces is to remove them by methodological decision. This means to adopt the convention that universal forces be set equal to zero. What does it mean to set equal to zero a force that may lead to empirically detectable deformations? Reichenbach's point becomes clearer if it is realized that a serious candidate for a universal force exists, namely, gravitation. Gravitational forces act on all materials alike, and setting universal forces equal to zero is supposed to capture the gist of Albert Einstein's geometrization of gravitation: gravity is not treated as a physical force (at least not locally) but as a manifestation of space-time structure. The effects of gravitation are not attributed to a deforming force but to the metric structure itself (Reichenbach 1928, 19–39; see Carrier 1994b, 142–154).

Reichenbach defends two claims in connection with this approach. First, dealing with universal forces involves a serious conventional choice, and, second, after this choice has been made, physical geometry is fixed unambiguously. It is Grünbaum's ambition to support Reichenbach in this twofold respect. As to the first item, a universal-force approach to gravitation is the Newtonian one in which gravitational forces act in a fixed spatiotemporal background. By contrast, Einstein's geometrized gravity considers motion under the sole influence of gravitation as the straightest spatiotemporal trajectories possible under the conditions at hand. No force deviates bodies from their straightest paths. If geometrized gravity is transformed into a Newton-style universal force, not all such manifestations of this force can be traced back to sources (such as other masses). After all, Newtonian gravity and Einsteinian general relativity are empirically different, and this difference among the observed effects cannot be attributed to physical causes of the universal force field. There is no mass that advances the rotation of mercury's perihelion to its Einsteinian value.

Today, causal explicability is often seen as a virtue that increases a theory's truth. Following Ernan McMullin (1982), the satisfaction of epistemic values such as unifying or predictive power is able to boost a theory's confirmation and to make it approach closer to the truth than empirically equivalent counterparts that lack these distinctions. Applied to Reichenbach's scenario this means that in view of the fact that all of the allegedly conventional alternatives to standard general relativity lag behind the latter methodologically, these alternatives are wrong; no conventional choice among them is called for (Putnam 1963; 1975). By contrast, Grünbaum emphatically defends the empiricist creed. Each substantial confirmation of a claim needs to be empirical. Causal explicability is a non-empirical virtue which makes a theory pragmatically preferable and more convenient to adopt but not an objective merit that could justify a superior truth-value. Grünbaum rigorously supports the empiricist position that the only thing that counts regarding credibility is experience (Grünbaum 1963, 66–73). In this vein, physical geometry is an abstraction formed on the basis of geometric measurements. By contrast, the prevalent view today is to regard geometric quantities such as the metric and geodesic structures as theoretical quantities that are connected to various empirical indicators but not identical with any one of them. The primary merit of theories is the understanding they provide or the truth they can rightly lay claim to rather than merely representing measurement results.

Second, Grünbaum defends Reichenbach's claim that deciding about universal forces is sufficient for singling out physical geometry. Einstein objected to this claim by advocating a holistic, Duhem-inspired view. In Grünbaum's improved reconstruction of Einstein's argument, not only universal forces, but differential forces as well invalidate the unambiguous determination of physical geometry. The concept of length already enters into correcting deformations of measuring rods that are due to thermic expansion, mechanical stress, etc. For this reason, performing differential corrections presupposes that the true geometric relations be already known. But these relations can only come to be known by resorting to the correction laws. This reciprocal dependence between geometric relations and differential distortions induces a circularity that vitiates the separate determination of physical geometry (Einstein 1949, 676–678; Grünbaum 1960, 78–80; 1963, 131–135; 1966, 283–295; 1973, 285–294).

It deserves notice that Einstein's argument does not simply come down to stressing Duhemian holism but rather suggests that differential corrections lead into the same correction circularity that Reichenbach had diagnosed for universal forces. The Duhemian predicament concerns the intertwining of hypotheses that are logically independent of each other. Testing a hypothesis needs to take recourse to ancillary hypotheses, but testing these latter hypotheses does not necessarily presuppose the first hypothesis. Einstein's argument is more specific in envisaging a situation in which testing geometric relations requires reference to geometric relations. This circularity looks like the one elaborated by Reichenbach. Einstein develops a differential analog of Reichenbach-conventionality. And this means that geometry remains conventional even after Reichenbach's recommendation has been applied (Carrier 1993).

Grünbaum undertakes to dissolve Einstein's criticism by devising a stepwise correction procedure for distorting differential effects such as temperature variations. Grünbaum considers a situation in which only thermic distortions are present. In this case one starts with an arbitrary geometry in the correction law for thermic expansion and determines the geometry with the help of rods corrected by this law. The geometry obtained will not in general coincide with the one employed in the correction. Thus, one uses this measured geometry for effecting the correction a second time and again applies the rods corrected in this improved fashion to determine the prevailing geometric relations. This procedure is repeated until an agreement is reached between the geometry that enters into the correction law and the geometry that is obtained by performing measurements with the corrected rods. There is no guarantee of convergence, but if a unique geometrical system ensues, it is sensible to identify this system with the geometry of space-time. One of the preconditions for this recipe to work is that the distorting temperature variations remain unchanged during its application (Grünbaum 1960, 80–83; 1963, 140–146; Carrier 1993).

Two things command attention. Grünbaum's procedure virtually agrees with Hasok Chang's "epistemic iteration." Epistemic iteration is a self-correcting process that transforms a circularity into a convergent spiral, as it were. In thermometry you need fixed points (such as the boiling point of water) in order to establish a reliable temperature scale and to build a metric thermometer. Yet, you need such a thermometer so as to ascertain the fixity of these assumed fixed points in the first place. Chang suggests beginning with sensory experience of hot and cold, then move on to non-metric procedures (thermoscopes) that tentatively establish fixity and build a first thermometer on this basis. This thermometer is used for evaluating distortions and correcting them. The corrections serve to construct an improved thermometer which is used for administering enhanced corrections, and so on. The expectation is that this process will converge (Chang 2004, Chs. 1, 5). The key idea of this ingenious procedure originates with Grünbaum: transforming an apparent circularity into a convergent spiral toward a fixed value.

Second, Grünbaum's anti-Einsteinian argument is characteristic for his life-long opposition to Duhemian holism. Grünbaum's point is that this holism is not a general truth and that, conversely, particular circumstances may allow the more specific testing of individual hypotheses. Grünbaum argues that it is a matter of contingent fact whether individual hypotheses can be examined and, as the case may be, refuted, or whether scientists can freely shift the blame for a faulty prediction across the network of assumptions involved. In the spatiotemporal case at issue, Grünbaum insists that differential distortions do not block the unambiguous empirical determination of physical geometry. Universal and differential factors can be treated separately, this is Grünbaum's anti-holist message.

Grünbaum's opposition to Duhem's thesis, so-called, is directed at and confined to the following strong assertion: given a hypothesis *H*, a set of auxiliary assumptions *A*, and an observation statement *O* in conflict with this set of claims, then there always exists a non-trivially distinct alternative set A' such that *O* is in agreement with *H* & A'. That is to say, Grünbaum takes Duhem to claim that each and every hypothesis can be saved in the face of each and every observation by adjusting the theoretical context of the hypothesis in a non-trivial fashion (barring mere semantic reinterpretation). Grünbaum endeavors to refute this alleged Duhemian thesis by pointing to two counterexamples from physical geometry: dissolving Einstein's correction circularity is one of them, the identification of undistorted cases without much theoretical baggage is the other one. In both cases, as Grünbaum claimed, physical geometry can be determined unambiguously, which is tantamount to saying that prior conjectures about the prevalent geometric relations can be refuted (Grünbaum 1960; 1963, 140–146; 1966).

The chief issue in the ensuing debate concerned the nature and content of Duhem's thesis. For instance, Larry Laudan pointed out that Duhem had actually advocated the weaker claim that in the above scheme it can never be proven that *H* is the culprit. Accordingly, the possibility of finding an alternative set A' and of preserving *H* in the face of *O* can never be precluded (Laudan 1965). Grünbaum's argument is compatible with this weaker version (as he later acknowledges (Grünbaum 1966, 282)).

Grünbaum's general aim is to preserve elements of falsificationism. Facts may militate so strongly against a particular hypothesis that no credible rescue operations are left. Unfortunately, Grünbaum's examples from physical geometry are cooked up and lack the air of real science, but we will return to this issue in the psychoanalytic context. Speaking more generally, Grünbaum could have pointed to the falsificationist effect the discovery of the phases of Venus had on the tenet that Venus orbited the Earth. Once this discovery had been recognized by the scientific community, the Ptolemaic system was considered refuted and geocentrism survived only in its Tychonic version. Accordingly, Grünbaum's instinct that 'killer facts' exist is borne out, although he failed to support his case to the satisfaction of his fellow philosophers.

The traditional argument for the conventionality of space-time, as elaborated by Grünbaum, is epistemological: there is a leeway left in testing claims about spatiotemporal relations. However, in Grünbaum's view, this epistemological room is based on deeper ontological features of the space-time manifold or the ensemble of spatiotemporal points. He draws on Riemann's Inaugural Lecture, delivered in 1854, in which Riemann distinguishes between discrete and continuous manifolds. While in the former, "the principle of metric relations is implicit in the notion of this manifold, it must come from somewhere else in the case of a continuous manifold" (quoted in Grünbaum 1963, 8). A discrete manifold possesses separate elements such as the set of natural numbers. Intervals of discrete manifolds can be compared by counting; relations among such intervals rely on inherent features of the manifold. This is different for continuous sets such as the real numbers. Assessing quantities among the latter depends on bringing an external standard to bear. Establishing length relations in a continuum demands a rigid rod or some other physical procedure that does not hook up with internal characteristics of the continuum.

As Grünbaum explained, the mere continuity of a manifold is not sufficient for the lack of an intrinsic standard of interval size. If in a continuous manifold the individual elements differ in their qualitative properties, an intrinsic assessment of interval size or the distance between elements can be provided. For instance, colors constitute a continuous manifold, but the qualitative difference of individual colors allows for deriving a distance relation between them. This relation would be based on the intrinsic features of the elements of the manifold. By contrast, the elements of the spatiotemporal manifold are homogeneous and do not allow any such derivation. Grünbaum concludes that the continuity and homogeneity of its elements make the corresponding manifold "intrinsically metrically amorphous." Its structure prohibits building any metric relations on its internal properties.

In sum, the ontological structure of the space-time manifold suggests that metric structures need to 'come from somewhere else,' i.e., they are external to the manifold. More specifically, spatiotemporal metric relations need to be established by relying on bodies, that is, rigid rods and reliable clocks. Since metric relations in the manifold derive from relations external to the manifold, these metric relations are definitions and, accordingly, subject to convention. The ontological structure of space-time precludes building its metric relations on its inherent properties. It is the 'intrinsic metric amorphousness' which generates the need to introduce such relations from outside. This is said to be tantamount to granting the conventional nature of any such relation.

We conclude this section by placing Grünbaum's philosophy of geometry in the framework of philosophy of science of the period. Actually, Hilary Putnam's criticism of Grünbaum's approach, to which we briefly alluded before, indicates that a paradigm shift in the philosophical accounts of scientific theories occurred in the 1960s, precisely when Grünbaum developed his thoughts on the matter. The relevant shift is the transition from empiricism in the Viennese style to the double-language model or the theoretical context account of meaning. We had mentioned that Grünbaum's views on physical geometry have been shaped by the idea that exploring space-time starts with measuring spatiotemporal relations. We begin with rods and clocks, and the leeway we encounter in constructing spatiotemporal relations is tantamount to the choice left to physical geometry. The quantity relevant to philosophical consideration is the evidential basis of physical geometry. By contrast, Putnam (1963; 1975) approaches space-time structure from a theoretical angle. Relevant notions are the metric and the geodesic structures, that is, theoretical terms that are multiply instantiated. "Space-time geometry is not about 'bodies and transported solid rods' except in a derivative sense, but rather about the metrical field. […] This is a physical field in the sense of 'physical' relevant to scientific inquiry; we can detect its presence in a variety of ways […], and its presence enables us to explain, and not just describe, the behavior of solid bodies and of clocks" (Putnam 1963, 94–95). General relativity explains such behavior by resorting to higher-level laws about the interaction between matter and curved space-time. In this framework, the conventionality of physical geometry would mean that an alternative system of laws of nature could be given that accounts for the variety of pertinent observations equally well. But there is no question about that. General relativity is superior to possible alternatives, and within general relativity the metric is unambiguously specified. For Putnam, it is not a sensible endeavor to build up physical geometry by fumbling around with rods and clocks, and given a network of laws of nature, physical geometry is fixed. Physical geometry is not conventional in any tangible sense; it is rather fixed by the coherence of the network of the pertinent laws of physics (Putnam 1975, 165). Regarding Grünbaum's ontological argument, Putnam wonders why the set of Riemannian geometries, along with all their topological features, is privileged by Grünbaum, while the fact that only particular metrics are suited to account for a variety of phenomena is disregarded altogether (Putnam 1963, 102–103; Carrier 1994a).

In the judgment of most present-day philosophers of space-time, Putnam indeed inaugurated a new approach to interpreting concepts of physical geometry and thereby superseded Grünbaum's general account—although many details within the latter still strike us as highly sophisticated.

3 Grünbaum on the Direction of Time

Since the struggle between Parmenides of Elea and Heraclitus of Ephesus, few questions have offered comparable allure and produced similar confusion in philosophical minds as the issue of whether the observed directedness of change is essential to nature and part of nature's workings or whether it is a feature exclusively pertaining to the human mind. Twentieth-century representatives of the Eleatic timelessness of nature include Hermann Weyl and Kurt Gödel, while Emile Bergson was a forceful advocate of Heraclitean flux. Modern Eleatics stress the symmetry of both time directions in the laws of nature and insist that the distinction between earlier and later is confined to a particularly human point of view. Modern Heracliteans claim that genuinely new objects and arrays emerge in nature; what happens now is not laid out completely in the preceding events. Nature advances and brings forth unprecedented novelties. Grünbaum has articulated a view in the middle ground between these two extremes: temporal processes exist that are intrinsically or by nature directed or anisotropic, but this anisotropy is merely factual and without nomological foundation. In addition, Grünbaum denied that the 'present' has any counterpart in natural processes. The idea of a distinguished point moving through time has no basis in physics; 'becoming' in this sense is a psychological feature only. Grünbaum proceeded from Reichenbach's posthumous book *The Direction of Time* (1956) and essentially agreed with its conclusions, but he elaborated this position and brought out its conceptual characteristics more clearly.

Grünbaum chiefly discusses the directedness of time in Chapter 8 of his *Philosophical Problems of Space and Time* (1963). His key notion is the anisotropy of time. Time is anisotropic if irreversible processes exist, that is, processes that unfold in one direction only. Time is intrinsically anisotropic, in addition, if this preferred temporal order does not depend on a human point of view. Irreversible processes would confer intrinsic anisotropy to time; they would provide a basis for distinguishing objectively between earlier and later points in time. But the question is whether genuinely irreversible processes exist in nature. It is true, a large number of processes advance in a preferred direction. This is how we recognize movies played backward. People rarely move rearward on their own and they do not jump three meters up into a tree. However, people could do such things without violating the laws of mechanics. Walking backward would be a collision-prone venture, and we lack the physical strength to perform giant leaps (while the reverse motion is easily accomplished with the kind assistance of gravitational pull). Arguing in this fashion means shifting the yardstick for judging about the 'existence' of irreversible processes from observation to the underlying system of laws. That is, an irreversible process is such that the corresponding time-inverse is ruled out by the laws of nature. The trouble with this shift toward 'nomological irreversibility' is that all major theories of physics allow the time-inverse of processes specified in their framework. Walking and jumping testifies to the nomological reversibility recognized by the laws of mechanics. The non-existence of the time-inverse of certain mechanical processes is due merely to contingent circumstances. The same applies to electrodynamics, the relativity theories, and even to quantum mechanics (with the exception of the notorious collapse of the wave function whose nature and even existence is subject to enduring controversy).

Thermal processes appeared to offer a refuge in the mid-nineteenth century. When entropy increase was considered a deterministic law of nature, processes such as the spontaneous creation of temperature differences out of thermal equilibrium were ruled out on a nomological basis. The Second Law of Thermodynamics could thus be used for distinguishing between earlier and later states: higher temperature differences in closed systems represent a state earlier than thermal equilibrium. In other words, a nomological basis for the anisotropy of time could be assumed. However, this aspiration was dashed by Ludwig Boltzmann's reduction of thermodynamics to statistical mechanics. Boltzmann gave a probabilistic estimate of how the molecular collisions in an ideal gas changed the average energy and momentum values of the molecules. He defined entropy in statistical terms as molecular disorder and derived the conclusion that the most probable development of an ideal gas leads toward states of higher molecular disorder or entropy (Carrier 2009, 75–81).

Two philosophical conclusions merit attention. The first is that Boltzmann's probabilistic approach could not proceed successfully with exact molecular quantities such as momentum and energy values. The reason is that the probability for each of these precise values to obtain in a gas is equal and negligibly small. In order to make a statistical treatment possible, Boltzmann introduced intervals for the mentioned quantities. Only by creating such a coarse-graining, different occupation numbers of the intervals and thus different probabilities ensue for the molecular states in question. Joshua Gibbs objected that this substitution of exact values with intervals is a human invention and that the statistical estimates made on this basis are the result of human imagination. In reality, no such intervals of molecular quantities exist, but only their precise values do. Accordingly, the rise of molecular disorder and, consequently, of entropy is generated by this coarse-graining and not a fact of the matter (Carrier 2009, 89–90).

In one of his most subtle pieces of philosophical reflection, Grünbaum showed that this reasoning is mistaken. While it is true that the occupation numbers of the intervals of energy and momentum values depend on the interval sizes chosen, the changes of these numbers do not. Different modes of coarse-graining lead to the same increase in molecular disorder, with the result that the probabilistic increase of entropy is a fact of nature (Grünbaum 1973, 648–659; see Carrier 2009, 90–91).

Grünbaum's second insight proceeds from Reichenbach's work but is elaborated much more clearly. In its statistical interpretation the Second Law in and of itself does not provide a basis for the anisotropy of time. Rather, in thermal equilibrium, molecular disorder oscillates irregularly around its equilibrium value. No preferred direction emerges from considering entropy. And this is how it must be since the underlying laws of mechanics are reversible. The crucial item is to invoke factual conditions in addition. The Second Law says that given a nonequilibrium state of lower entropy or higher molecular order, the large majority of its potential paths of development lead to equilibrium states of higher entropy or lower molecular order. Reichenbach introduced the notion of "branch systems" by which he referred to low-entropy systems that have been produced by particular circumstances or human intervention. Pouring ice into a glass of soda creates a branch system. This system branches off thermal equilibrium and assumes a low-entropy state. With overwhelming probability, the time evolution of such branch systems exhibits a preferred direction. It is the probable increase of entropy in such nonequilibrium systems that provides a physical basis of the anisotropy of time (Reichenbach 1956, 111–112, 117–118; Grünbaum 1963, 241–244, 254–261).

Grünbaum brings out the philosophical gist of this approach by granting, first, that the anisotropy of time is not grounded in the laws of nature. These laws are isotropic; they only recognize reversible processes and thus fail to single out a direction of time. Yet, second, it is the laws of nature together with distinguished initial and boundary conditions that introduce the difference between 'earlier' and 'later.' That is, the anisotropy of time is intrinsic; however, it is not nomological but rather factual. Third, factual anisotropy is sufficient for ascribing a directed time to nature. Grünbaum takes pains to defend the latter claim against critics such as Henry Mehlberg who contend that branch systems are mere local asymmetries and that because of their local nature these systems fail to confer anisotropy to time. After all, we consider space to be isotropic in spite of the fact that preferred spatial directions exist on earth. Grünbaum replies that branch systems are not local but exist across the universe and that, in addition, the dependence of irreversible processes on initial and boundary conditions does not make these processes less irreversible. The expectation that cream and coffee segregate spontaneously is no less frustrated if the non-occurrence is due to non-existing factual conditions or contrary to laws of nature (Grünbaum 1963, 210–211, 258, 272–273).

In our judgment, the Reichenbach-Grünbaum account of the anisotropy of time is still the best account available. It is able to accommodate most other instances of unidirectional processes, most notably cosmic expansion. On this basis, we may safely conclude that the direction of time has a basis in physical processes. The thermodynamic arrow of time, if rightly interpreted along Grünbaum's lines, overrules Eleatic intuitions.

A novel and unexpected basis of anisotropic time has emerged in particle physics. It has been discovered over the past decades that various types of meson decay are irreversible in the sense that the time-inverse occurs with a slightly different frequency. Moreover, these decay processes are nomologically irreversible in that their irreversibility follows from basic principles of physics (PCT invariance). What puzzles philosophers is that these processes are extremely rare and that the difference between the process and its time-inverse is extremely small. Nothing of relevance in this realm plays any role in the world of common experience. It is striking that nomological irreversibility has been discovered for the first time; but it is even more striking that this feature has emerged in a remote corner of the physical world. What a glaring discrepancy between the potentially revolutionary character of this discovery and its apparent practical insignificance. In view of this confusion, the Reichenbach-Grünbaum account of temporal asymmetry is still the best one on offer (Carrier 2009, 103–106).

In 1908, John M. E. McTaggart introduced the distinction between two ways of understanding time. One is based on ordering temporal events according to the earlier–later relation (the "B-series"), the other one is focused on one of these events as the present moment (the "A-series"). Grünbaum adopted this distinction and also endorsed McTaggart's claim that earlier–later relations are part of nature, while the 'present' is not. In contrast to McTaggart, Grünbaum did not proceed from this latter claim to the 'unreality of time.' As just explained, Grünbaum rather supported the intrinsic anisotropy of time. McTaggart argued against the distinctive nature of the present by emphasizing the relativity of each selection of this present. Viewed from different points in time, other such points belong into their past, present, or future. Consequently, the present, and the corresponding distinction between the past and the future, is not objective and, hence, unreal (McDaniel 2016). This argument has been widely received. The boundary between the past and the future is said to be dependent on the observer, which is taken to imply that there is no objective 'now.' Nature is timeless (Esfeld 2002, 34). The counterposition is that there is 'becoming' in nature. Qualitative novelties are produced by the 'creative advance' of nature. The future is open, while the past is fixed. And the point at which the branches of potentialities collapse into a single bough and become factual is the present (Čapek 1961, 334–340; see Grünbaum 1963, 319–321; 1971, 489–492).

Grünbaum follows McTaggart's argument (which he attributes to Hugo Bergmann) that the transition from possibility to reality is unable to distinguish any point in time. Even in an indeterministic universe, the collapse of possibilities indiscriminately happens at each point in time. One could reply that the potentialities of 1923 have already come into being a long time ago, while the present opportunities become factual, or fail to do so, right now. But the latter transformation occurs 'now' only now—so that this explanation is circular (Grünbaum 1963, 322–323). In Grünbaum's view, the present means to become consciously aware. Becoming is a purely psychological category; it has to do with the fact that different experiences enter consciousness at different times. Becoming is no property of the physical world, but derives from the egocentric perspective of sentient beings (Grünbaum 1963, 217–218, 226, 321–325).

4 Grünbaum on the Methodological Credentials of Psychoanalysis

In addition to space and time, Grünbaum's second major scholarly occupation was the methodological analysis of Sigmund Freud's psychoanalytic theory. Grünbaum sought to point out the relationship of this theory to the relevant evidence and to assess the empirical justification, or lack thereof, of psychoanalysis. Freud had worked out a universal account of the mind which included general psychological mechanisms that were thought to become manifest in various instances. The two examples we focus on are psychoneuroses and dreams.

Freud's causal picture of the formation of neuroses features an infantile traumatic experience of a sexual nature that is hidden from conscious access. Retrieval is blocked by mental censorship because its 'forbidden' character would create fear if the adult person became aware of it. Memories that are actively prevented from becoming conscious are 'repressed.' However, the underlying experience still affects mental dynamics in disguised form. Among the indications of this influence are psychological and somatic symptoms. In other words, a neurosis has developed. Similarly in dreams. Infantile wishes of a sexual nature would create anxiety or disgust if they were acknowledged.

Thus, again, these wishes are actively barred from becoming conscious; they are repressed and inaccessible. But they make their appearance in veiled form in dreams. Dreams involve the vicarious fulfillment of repressed infantile wishes.

In both cases, it is difficult to get access to the repressed memories. They equally underlie the neurotic symptoms and the manifest dream content, but mental censors wield resistance to bringing these true causes to light. Matters are made more complicated by the fact that various other memories are intermingled with the experience in question. Much of the manifest dream content is shaped by the 'day's residues.' Freud's method for revealing these hidden mental causes is 'free association.' The patients start from the relevant material, such as the symptoms or the dreams at hand, and utter unhampered whatever comes to their mind. Freud's idea is that in allowing themselves to just follow their imagination, the patient's awake mind is relaxed and its guarding or constraining influence reduced. Yet, this stream of consciousness in itself would fail to reveal to the patient the repressed event or wish in question. After all, censorship is only weakened and not removed. This is why the associations produced include the repressed mental incident in altered form only and amalgamated with lots of unrelated psychological material. As a result, the psychoanalyst needs to guide the patient's associative chain of utterances, select the key items, and offer an interpretation eventually. This means that the diagnosis is supplied by the therapist's winnowing and sifting and not created by the analysands themselves (Grünbaum 1987, 77–79; see Carrier 1994b, 104–109).

The question is why Freud believes that this diagnosis, in spite of being crafted by the therapist, faithfully represents the patient's psychodynamics. In Grünbaum's reconstruction, Freud's argument is that only such interpretations will be therapeutically successful that 'tally with what is real' in the patient. That is, if the reconstruction of a repressed mental event offered by the therapist is 'relived' by the patient, i.e., not only accepted intellectually but also experienced emotionally, a 'cathartic' comprehension or 'abreactive recall' emerges that dissolves the symptoms in question. Grünbaum denotes Freud's argument, in view of the phrase above, the "Tally Argument." In Grünbaum's reconstruction, the argument says that only if the repressed traumatic memories identified in this way are the true causes of the disorder, can we expect their disclosure to be therapeutically effective. Durable therapeutic success and the lasting disappearance of symptoms can only occur if the actual pathogens of the affliction have been recognized and removed by psychoanalytic catharsis. As a consequence, although the therapist exerts a suggestive influence on the patient, therapeutic success testifies that such suggestions act merely as a catalyst in the excavation of repressions (Grünbaum 1984, 127–135; 1987, 79, 118–119).

Grünbaum expounds this argument as Freud's chief reason for the claim that clinical evidence can validate his theory. Persuasive suggestions and fanciful pseudo-insights that merely ring plausible to the patient are unable to cure a neurosis (Grünbaum 1984, 138). However, as Grünbaum points out, there is no analogy to therapeutic success in the interpretation of dreams. It is only the claimed universality of Freud's psychodynamic account that justifies the assimilation of dreams to neuroses or buttresses the understanding of dreams as mini-neuroses. There is no independent evidence for treating the two in parallel (Grünbaum 1984, 229–230; 1987, 94–95).

Grünbaum's methodological analysis of the empirical underpinning of Freud's theory is intended to support two major claims. First, in contrast to allegations prominently advanced by Karl Popper, psychoanalysis can be falsified. That is, Grünbaum carries his opposition to Duhemian holism into the psychological realm. Second, contrary to Freud's aspirations, psychoanalytic claims cannot satisfactorily be tested within the therapeutic setting. In fact, Freud's psychodynamic account is poorly tested and, in part, falsified.

As to the first claim, Grünbaum argues that Popper has not paid sufficient attention to the fact that psychoanalysis contains a number of specific causal assertions (Grünbaum 1983, 322). For instance, if no repressed infantile traumatic experience can be retrieved in a neurotic patient, psychoanalysis is in trouble. Moreover, Freud acknowledged such threats of refutation. When he initially failed to unearth a conflict-ridden homosexual relationship in a patient afflicted with paranoia, he spoke of a case "running counter" to his theory. Likewise, he considered it a counterexample to this wish-fulfillment account of dreams that traumatized soldiers relived their horrible experiences in their dreams. Freud withdrew to the position that dreams are attempts at wish-fulfillment, attempts that could fail. Grünbaum emphasizes in addition that Freud never came to grips with the objection that ordinary anxiety dreams contradict his wish-fulfillment account (Grünbaum 1984, 108–109, 238; 1987, 99–100). Moreover, later studies have shown that psychoanalytic treatment is no more successful than alternative approaches that rely on other causal mechanisms (Grünbaum 1987, 120). This finding unhinges the Tally Argument since no particular mechanism is singled out as the true one. There is no scarcity of falsifiability and even falsification. It is true, conflicts with experience can often be fixed by adjusting auxiliary assumptions. But psychoanalysis is no different than other theories in this respect, and Popper's claim is stronger in that any serious conflict with behavioral evidence is said to be ruled out. Grünbaum is right in judging Popper's charge of non-testability to be ill-founded and rightly concludes that Popper's falsifiability criterion is unable to pinpoint the methodological deficiency of psychoanalysis (Grünbaum 1987, 99–102).

Grünbaum's second claim is that the causal hypotheses Freud entertains cannot possibly be sufficiently confirmed by the evidence on which Freud draws. Freud exclusively relied on data from his patients. Grünbaum rightly points out that this constraint to the therapeutic setting prohibits convincing empirical support. Grünbaum appeals to John Stuart Mill's joint method of agreement and difference (Grünbaum 1983, 335; 1984, 257; 1987, 106–107): if a series of conditions precedes or co-occurs with an effect, a cause, or part of it, can be identified by removing these conditions bit by bit and registering when the effect disappears. In Freud's case, relevant assertions are such that a specific pathogen P (a trauma in childhood, a conflict-ridden homosexual relation, etc.) brings about a certain disorder D (a neurosis, paranoia, etc.). These relations are meant to be specific; they are modeled on Robert Koch's tuberculosis bacterium which also brings about one particular disease (Grünbaum 1984, 110). Thus, Freud's claim is that $P \rightarrow D$, and in the clinical framework, all available cases exhibit D. Freud tried to underpin this alleged relation by eliciting the retrieval of P in the so afflicted patients.

However, in order for this relation to be a causal one, it should also be the case that non-exposure to the pathogen should not go along with the disorder: non-$P \rightarrow$ non-D. But these latter cases never show up on Freud's couch. In other words, in order to check and confirm his causal claim, Freud would have needed a control group. Similarly, rather than just reconstructing the past event P from the disguised recollection of patients suffering from D, confirming the theory would require prospective testing in that people experiencing P would be followed over time and the rate of D in their later life recorded. The rate of D among people going through P and not suffering P should be significantly different. These two critical test designs break the confines of the clinical framework (Grünbaum 1983, 328, 333–335; 1984, 253–254; 1987, 104–105). Moreover, Freud would have needed a placebo-control in which patients afflicted with D were left untreated or were treated on an alternative basis. Suggestions and interpretations unrelated to the psychoanalytic picture of the mental furnish relevant options. Therapeutic success should be lower in this placebo group or groups. The success of placebos is based on factors not considered relevant by the approach under scrutiny. In the case at hand, a placebo effect could be due to attentive and affectionate listening without any excavation of infantile traumas. Placebo control would have been possible in the clinical framework but Freud failed to achieve it. As briefly mentioned before, later studies showed that therapeutic success is approximately the same in various competing psychotherapeutic schools, which suggests that the therapeutic success of psychoanalysis relies on the placebo effect (Grünbaum 1987, 79–83).

Grünbaum's overall methodological claim is that psychoanalysis can be tested empirically but requires tests of a kind different from those Freud envisaged and performed. Grünbaum is certainly right in this regard. Still, what is striking is his lack of charity vis-à-vis Freud. While Grünbaum insists that the methodological standards he invokes are essentially Freud's own (Grünbaum 1987, 78), it should also be acknowledged that placebo controls and control groups are much more common today than in Freud's time. Furthermore, Freud is not the only innovative scientist who committed methodological blunder. Louis Pasteur seems to have proceeded rather carelessly in his argument against spontaneous generation. He apparently failed to address many of the objections his opponent Félix Pouchet had raised (Farley and Geison 1974; López Cerezo 2015). Pasteur was luckier than Freud in that he happened to bet on the right horse. But Pasteur's victory was not won by his superior methodological expertise. The point is that placing Freud in the wider context of the history of science might have cast a more favorable light on his endeavors.

Second, speaking at the substantive level, Grünbaum does not give Freud credit for his major achievements. Freud invented the talking cure; he discovered that words can heal. Moreover, his theory picked the appropriate conceptual level, namely, cognitive mechanisms that latch on to intentional, content-sensitive mental states. Freud did not promote physiological and behavioral reductionism, and in opposing behaviorism he forged a conceptual link with the cognitive revolution of the 1960s. This conceptual level of cognitive mechanisms has proven fruitful; the therapeutic accounts emerging within 'humanistic psychology' since around 1960 are akin to Freud's approach in conceptual respect—albeit different substantively. As a result, Freud's heritage goes beyond psychoanalysis in the narrow sense. It includes large chunks of present-day psychotherapy. In spite of his errors in psychodynamic detail, Freud has shaped large parts of the contemporary psychotherapeutic landscape in conceptual respect. This is not a small achievement, and it would have merited Grünbaum's appreciation.

5 Grünbaum and God

So far, we have described Adolf Grünbaum as a highly sophisticated and professional philosopher of science, who wrote for his fellow philosophers and scientists interested in epistemological, methodological, and philosophical aspects of their discipline. Already his methodological examination of psychoanalysis, however, reached out to a broader public, given the role of psychoanalysis in American society. His criticism of theism, finally, shows Grünbaum as a public intellectual, who emphatically promotes secular humanism. This is an enlightenment movement that originated in the US in the 1920s and 1930s. It advocates a rational, evidence- and argument-based approach to understanding nature and to ethical questions. Usually, but not necessarily, it includes atheism. Grünbaum was one of the most fervent supporters of atheist secular humanism (Grünbaum 1992).

Grünbaum's atheism is deeply rooted in his biography: "Already in my early teens, I came to abandon biblical theism in which I was reared, in favor of atheism" (Grünbaum 2009, 11–12). One of the reasons was the "moral outrage" he felt about the story in *Genesis* 22, where God requires Abraham to sacrifice his son Isaac "as a test to his fealty to God." Another one emerged from his Hebrew class were they were reading the Torah. Young Adolf did this with "surreptitious use of Martin Luther's excellent German translation as a pony. I soon learned that *Yehovah* (in Germanically pronounced Hebrew) was supposed to be God's *true name*. […] As I knew, no good Jew was allowed to pronounce that name, a prohibition smacking of the semantic confusion between name and the object. Thus an array of substitute names were coined. […] So when my turn came to read a Torah passage containing the hallowed word, I blithely pronounced it loud. That turned the Hebrew teacher, a Dr. Stein, simply apoplectic. Pounding the table thunderously, he expostulated what I had done is just the worst thing a Jew can do!" (Grünbaum 2009, 17–18). Ironically, it was the rabbi of the conservative Glockengasse synagogue in Cologne, who raised young Adolf's interest in philosophy. He talked about philosophers like Immanuel Kant and Georg Wilhelm Friedrich Hegel and encouraged 12-years-old Adolf to equip himself with the philosophy volume of the book series *Kultur der Gegenwart.* Arthur Schopenhauer became his favorite. "What I could understand of his writings completed my disenchantment with theism by the time of my bar mitzvah in 1936 at age thirteen." He, nonetheless, participated because "under the increasingly vicious Nazi government, it was imperative to show solidarity with the Jewish community in Cologne. Thus, it would have gravely embarrassed my parents and relatives if I had declined to go through with the bar mitzvah, so I did" (Grünbaum 1999, 25). This solidarity has remained. In his *Autobiographical Philosophical Narrative* he states: "My atheism coexists harmoniously with my strong cultural identification with some, though only *some*, of my Jewish patrimony" (Grünbaum 2009, 14–15).

Grünbaum clearly distinguishes atheism from agnosticism. Agnosticism deems unanswerable in principle the question whether God exists or not. Consequently, neither theists nor atheists are agnostics. "Deplorably, the ideologically coercive public religiosity in this country [the US] […] has intimidated many atheists to mislabeling themselves as 'agnostics'" (Grünbaum 2009, 24). Grünbaum's path to his brand of atheism is epistemological: the assertion of the existence of God is a theoretical belief like other beliefs, for example in physics. Theoretical beliefs are not infallible. They might change under the impact of new evidence. This holds also for both theism and atheism. In view of the evidence, however, Grünbaum cannot discern any cogent argument for the existence of God, while, second, he is convinced that he possesses telling evidence against it. This leads him, on the one hand, to refute arguments in favor of the existence of God that have been put forward by theists. On the other hand, he amasses evidence that is not compatible with the assumption of the existence of an omnibenevolent, omnipotent and omniscient God.

As to the theistic arguments for the existence of God, he singles out two: first, alleged cosmological support, and, second, the claim that without assuming the existence of God, no foundation of meaningful ethical directions can be specified.

As to the first item, Grünbaum deals with the creation from nothing (*creatio ex nihilo*) as the alleged cosmological support for theism. This is a distinct Christian precept that goes back to the second century C.E. Philosophically, it is embedded in the ontological question why there is something rather than nothing, first raised by Gottfried Wilhelm Leibniz. Grünbaum reformulates it as "why any contingent object exists at all rather than nothing contingent" (Grünbaum 2004, 561; see Grünbaum 2008a) and criticizes the unwarranted presupposition that 'nothingness' because of its alleged simplicity is the cosmological null hypothesis. His argument is that simplicity is no sign of truth (Grünbaum 2008b). In other words, there is no evidence that 'nothingness' is the default state and that the existence of the universe is in need of explanation. Thus, Leibniz's challenge creates a pseudo-problem or is a non-starter, as Grünbaum later prefers to call it (Grünbaum 2004, 564; see Grünbaum 1989). Furthermore, he makes clear that there is not the slightest evidence for a causal process that could have led from the supposed null-state of nothingness to our contingent world (Grünbaum 1991, 234). In painstaking criticisms, Grünbaum rejects all attempts to use current cosmological theories like the big bang in support of creationist theism.

As to the second item of the alleged indispensability of theism as a source of meaningful ethical directions, Grünbaum goes back to Plato's *Euthyphro* and asks with Socrates: "Is a conduct morally right, because of *properties of its own*, or merely because it pleases the gods to value or command it?" (Grünbaum 1992, 32; see Grünbaum 1995, 219–220). In the first case, the moral appropriateness of the conduct does not depend on divine command, in the second case, in a multi-religious world we are left with the insoluble problem, which one of the purported and often conflicting divine revelations we should accept as a source of morality. Therefore, the justification of moral rules must come from elsewhere. Grünbaum does not disclose which of the competing ethical systems he prefers.

Furthermore, in his critique of theism, Grünbaum touches on the old question how the evil in the world is compatible with the assumption of the existence of an omnibenevolent, omnipotent and omniscient God. The theodicy problem is, indeed, one of the toughest nuts to crack for theists, and Grünbaum accumulates ridiculous and even 'obscene' examples. One of the latter is the 1987 statement of the late "Lord Immanuel Rabbi Jakobovitz, the Chief Orthodox Rabbi of Britain and the Commonwealth […] that the Nazi Holocaust was a divine punishment for the apostasy of the German Jews. […] If Rabbi Jakobovitz is to be believed, the wrath of God is so indiscriminate that it prompted the Nazis to incinerate devoutly Orthodox Jews from all over Central Europe, no less than the supposedly wicked reform Jews of Germany" (Grünbaum 1992, 31–32).

6 Grünbaum: The Man

The two of us wish to confirm two thoughts entertained by Robert Cohen in his introduction to Grünbaum's *Festschrift* (1983) on his sixtieth birthday. First, Cohen highlights Grünbaum's particular style of communication. Whoever got a handwritten letter from Adolf is overwhelmed by his variety of ways of emphasizing certain aspects. Using *italics*, CAPITALS, underlining, and various colors all contribute to bringing out nuances of his thoughts. And letters he wrote. He regularly attended the Christmas party of the University's postal workers, in order to express his gratitude for the postal services rendered to him during the year. Second, in personal conversation Adolf was the most kind and gentle human being imaginable. No one could compete with the warmth of his consideration and empathy. But Adolf in print was different. As Cohen put it: "Grünbaum's personal sweetness, so immediately clear face-to-face, may not always be directly recognizable in his writings" (Cohen 1983, 14–16).

Despite Adolf's outstanding institutional achievements, his professional life in Pittsburgh "was not all champagne and roses," as Gerald J. Massey, a longtime friend and one of his successors as director of the Center for Philosophy of Science, put it at the Grünbaum Memorial at Pittsburgh University in May 2019 (personal communication). Grünbaum was unable to recognize and then to deal in a relaxed way with the usual intrigues and bureaucratic interventions that make up university life. He confessed: "One of the reasons for my myopia [with respect to supposed disloyal behavior of friends and colleagues], I believe, was that after my traumatic experiences in Nazi Germany, I craved a departmental and university environment in which my colleagues acted like a *benevolent, extended family.* […] But all in all, I have paid a considerable price for having been so naively trusting" (Grünbaum 2009, 141). The quarrels began, when in 1985, encouraged by its director, "the departmental graduate committee recommended without explanation that the core course in the philosophy of science be dropped, while all the other four remained on the roster" (Grünbaum 2009, 139). With the support of several colleagues this attempt could be aborted. Grünbaum was especially enraged by another episode. As he saw it, the above-mentioned director invented the story that students had complained about his critique of religion in his courses. "Some of the students were reported to have said, I were anti-Christian, not simply only atheistic but specifically an Anti-Christ. […] Even if this accusation from the side of students had really occurred, it would have been the duty of this individual in his function as teacher to explain to the student the great good of freedom of speech and of *Lehrfreiheit*" (Grünbaum 1994, 490). In 2003, Grünbaum, finally, resigned from the Department of Philosophy and moved to the Department of History and Philosophy of Science.

In situations like these, Adolf could rely on his wife Thelma Braverman (1925–2017), an excellent high-school teacher of mathematics. The two had already met in their high-school days in New York and got married in 1949. Everybody who had the good fortune to meet Thelma has been entranced by her kindness, wit, and good humor.

Adolf's at times a bit eccentric behavior should not overshadow the fact that he was a charming human being who captivated the people around him by his personal cordiality and his sharp mind. The two of us have great affection for Adolf, the man, and high esteem for Grünbaum, the philosopher.

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