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CAUSAL HORIZONAL RESEARCH IN COSMOLOGY

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1. Microcosmic and Macrocosmic Causality and Acausality

This essay treats a borderline issue among Philosophy of the Cosmos, Astrophysical Cosmology, and Quantum Mechanics. The present universe (if there is only this one, finite, big bang universe) and/or the whole multiverse (if there are other universes beyond our big bang universe) would have to be fully and thoroughly causal.[1] But there exist lacunae on the way to causality: both in the contemporary philosophical understanding of causality and in the theoretical recesses of micro- and macro-cosmic theories. Taking cue from my earlier work on microcosmic causality, I work here from the hypothesis that the microcosm is probably causal in all its infinitesimal parts.[2] The micro-world is thoroughly causal,

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[1]By 'thoroughly causal' I mean causally extending to all the infinitesimal aspects of the microworld and all the large scale aspects of the macroworld. Since the universe is constructed of what it is in its microworld, which combines to form the macroworld, the microworld processes and the macroworld processes supervene on each other. The context of the micro is the totality of causal structures in the macro, and the macro happens by combining the micro, which happens very much within the broader context of the micro-macro antecedents, from within the causalities of which the micro emerges, each time with something new contributed by the causal past of the macro and each time the micro contributing something of its own to the future of the micro and the macro. So, causality does not belong to just one of these two levels. Even if the probabilistic microworld is all causal, emergence of novelty in things would consist in effects from the subtler micro and broader macro levels from without the very particular micro and macro levels that are currently in question. Put differently, there shall be no aspect of the micro and macro levels of the world that is not causal and emergently contributive to many other spacetimes.

[2]See Raphael Neelamkavil, *Physics without Metaphysics? Categories of Second Generation Scientific Ontology*, Bangalore: Dharmaram Publications, 2006, especially Chapter 1. There exists a causal-acausal impasse in Quantum Mechanics and Cosmology, against the background of the general zeal of some physicists and

and, by sequel, the macro-world too is thoroughly causal within itself, whether the world is created or not! There are, however, some theoretical difficulties in our macrocosmic theories. So, we shall discuss the big bang theory as the most accepted macro-cosmic theory to date, point out its major defect in the questionable concept of causation at the singularity, and suggest that it is important to work towards filling the lacuna in order to build a thoroughly causal understanding.

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non-physicists (1) to intrude Cosmology with the statistical interpretation of quantum effects without recourse to the Law of Causation at the microcosmic level, (2) to unify Quantum Mechanics and Cosmology without the direct use of the Law of Causality, and (3) to label the uncertainty relation and the statistical interpretation of Quantum Mechanics (a) as the intrusion of consciousness – which they tend to take to be acausal and so infinitely different from matter, everywhere in the micro-universe, (b) as the substitution of cause with statistical explanation, and (c) as the intrusion of acausality in the physical / material. There is no substituting causation with statistical explanation in Quantum Mechanics, because one could not say that the quanta and the electrons are the ultimate particles, and that if they too are composed (which we know electrons already are) they would not contain inner causal structures and processes! Statistical explanation is only an attempt to summarily state just what we know by experiment, by refusing to rationally admit that all of physics presupposes further inner-quantal causation and, thus, causation everywhere. Sub-quantal, sub-sub-quantal and other more minute causes vouchsafe for the Law of Causation, not merely for causal theories. That is, what we have observed on the photographic plate, by use of an experiment that works at a certain level of minuteness of the subatomic, cannot be a substitute for the very condition for the possibility of each of the hits on the photographic plate! The fathers of Quantum Mechanics have compromised much on this fact. Hence their confusion between the causal and the acausal!

My line of argument on causality in the quantum world is as follows. If we consider the experiment of accelerating an electron in the double slit experiment or any other, by a beam of energy, this very action implies that we cause some effect in the electron, which already presupposes what we call causality in physics. Further, whatever thus perceivable as preceding in a consequential manner may be taken to be causal, in the very least not acausal. Therefore, there is no more reason to say that what is considered to be initiated causally produces something acausal out of nothing. None can show the line of transition from causation to acausation, using any micro-, meso-, or macroscopic theory, because they involve an irrational sort of infinite gulf. The context of this sort of infinity is purely arithmetical infinitesimality of elements, and appropriating a one-to-one correspondence relation between infinitesimals and elements of a whole number progression, as distinguished from infinities that do not depend on infinitesimals for validity. This presupposes the principle of absence of absolute discontinuity between two causally connected things, both of which evolve in the causal process.

I would like to put in gist the basis of our arguments and in the meantime define 'continuity'. Physics is impossible without the existence of physical / material processes. By existence we mean just the dimension of there being something in process; by process we mean anything other than pure staticity (i.e., partial staticity and partial fluency). If anything is in process, it cannot, ontologically, be mutually and infinitely differentiated things. That is, physically, objects are in association, and, whatever that mode of association, it signifies a finite force of attraction, and necessarily also a measure of repulsion. None of these phenomena can be active in an infinite measure in a finite spacetime,[3] or it would be against the very rationality of physically acceptable logic. These are some fundamentally ontological – not merely physical, but physical-ontological – facts about the universe. Their factuality is constant, although we may have any number of expatiations of the same, *ad libitum*. Therefore, they are physical-ontological dimensions of the universe, not finite facts.

Given the *constancy of factuality* of the fundamental ontological assumptions of science (not of their definitions, but of the factual dimensions that they represent), namely, the continuity, causality, etc., of the ontologically assumed actualities, then, inconstancy / discontinuity in the fundamental assumption of causality (not in things) is out of the question. Once again, by constancy, here, is not meant (1) the materially impossible temporal and / or spatial continuity of one thing with the other, (2) the similarly impossible temporal and / or spatial continuity of causation of one thing with another that is perceived to be the only cause, etc. Instead, even if things may be different and discontinuous with others in specific spacetimes, I would argue (1) that this spatiotemporal discontinuity in material bodies (events) does not vouch for an absolute spatiotemporal causal discontinuity anywhere, and (2) that the principle of continuity of 'total' causation of series of things by certain others (although, for it to be total, the description has to bring in the whole causal past) in any sort of event already implies that they are spatiotemporally indispensably causal. This refers to the genuine meaning of causality as the

[3]Spacetime may be defined as the measure of movement between two events. Minkowski formulated this concept for the Special Theory of Relativity, which Einstein extended to the General Theory, against the background of gravity. With respect to movements, spacetime is the real structure of events, which may be stretched, squeezed, rippled, or poked holes into by other spacetime events. *To this extent, spacetime is also the structure of the measure of movements caused by events.*

fact that everything flows causally from whatever in its causal roots has caused it. This more general and universal law is the Law of Causation, and it goes beyond the specific causal theories in specific sciences – which tend to mistake for law the fact of action of what is discovered as cause.[4]

The temporal and spatial world may have finitely spatiotemporal discontinuities. For example, the spatiotemporal distance of parts of the universe from 'singularities' – which should not have been called so, since they infinitize the finite spatiotemporality of the so-called centre of the big bang universe and of black holes – is an instance of spatiotemporal discontinuity. But, no event can have any discontinuous moment or place in which there is no causation in one and the same event, however dissimilar the different spatiotemporal parts of the event be, because there can either be some causal connection or not at all. In the latter case, however, infinite time lapses between the two parts of the event. The causal connection between the former and the latter lies not merely in the two immediately spatiotemporal former and latter parts of the event, but in the larger spatiotemporal context, in which many prior but anonymous spatiotemporal elements connect the former and the latter known events in question. Thus, causation extends beyond the immediate to the very causal horizon.

This continuity of causation, derived and justified from the causal horizon, is a presupposition of the present work. Such causation is not causal continuity in all of space and time, but instead, absence, in every particular part of the universe, of abstract, unconnected acausal moments or spaces. This absence dispenses with the continuity of whatever amount of acausality, available in statistical-physical explanations of the microcosmic- and singularity-bound causal conclusions[5] of quantum

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[4]We define 'causality' as the state of process of the universe in which every finite element – however close to infinitesimality its spatiotemporal extension is – influences in some way many others in its spatiotemporally non-infinite vicinity: the influence into the future being the effect/s, and influence from the past being the cause/s, both of which change in the process of causal affectivity. Whatever such influence may be, let us call it 'causation'. The Law of Causation is the most general statement of possibility of particular causes.

[5]"These models all predict the existence of a singularity at the very beginning, at which the temperature and density are infinite." *The Routledge Critical Dictionary of the New Cosmology*, s.v. "Big Bang," 132. Singularity may be defined as the mathematical (Euclidean?) point of spacetime at which the spacetime curvature is infinite. I have added 'mathematical (Euclidean)' to the simple definition by Yu. See

physics and cosmology. This is not just the conceptual aspect of causality somehow "pertaining to the cosmos of experience," but the very factuality of causality in the cosmos.

2. Causal Horizonal Questions in the Big Bang Theory

The big bang theory[6] is today the backbone of cosmology. Famously, the big bang model deals primarily with intra-cosmic causality, presupposedly

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Vladimiróv, N. Mitskiévich, and J. Horský, in *Space, Time, Gravitation*, Moscow: Mir Publishers, 1987, 158. Along with the alleged infinite spacetime curvature come also the alleged infinities of density, pressure, etc. I personally believe that the infinite spacetime curvature at the singularity is only ideally attainable, since at that point the geometry tends to be purely Euclidean. Although, in fact, theoretically the singularity is a mathematical point of no extension, cosmologists are prone to identify a physical content therein (due to the physical presupposition that for practical purposes the mathematical point is somehow to be equivalent to the physical point) and, then, call it a mathematical point of no extension at the centre of the big bang as the cosmic singularity or the black hole singularity, since it is a mathematical necessity!

[6]Abbé Georges Édouard Lemaître suggested the big bang model of the universe (1927), specially detailing theoretically its origin in an imaginatively appealing system. Alexandr Friedmann had found the big bang solution to Einstein's General Relativistic equations (1922), but had not worked out the early stages of the universe. By detailed observations of redshift of some galaxies from the Mount Wilson and later Palomar Observatories, Edwin P. Hubble argued (1929) that the universe is expanding with increasing recessional velocities of galaxies that are proportional to their distances from us. This was the first strongly observational support for Lemaître's big bang model. After the Lemaître and Friedmann models of the big bang universe came the Friedmann-Robertson-Walker expansion ("FRW cosmologies") of Einstein's equations. Roger Penrose, *The Road to Reality: A Complete Guide to the Laws of the Universe* (London: Jonathan Cape, 2004), 704. It was the nuclear physicist George Gamow who, by 1965, with the collaboration of Ralph Alpher, Robert Herman and a group of new generation cosmologists, made the big bang theory highly acceptable to physicists, through the work on the early stages of evolution of the universe. Helge Kragh, *Cosmology and Controversy: The Historical Development of Two Theories of the Universe* (Princeton: Princeton University Press, 1996), 81.

Today the big bang theory in altered shapes holds sway as the backbone of the expanding universe theory, and is also couched in General Relativistic equations, which do not take explicit support from the Law of Causality, but only presupposes it, because of its stress on spatiotemporal description of processes. Work is on to develop a quantum cosmology of the expanding universe, with or without the use of strings- and superstrings theories. Three most accepted reasons may be given for the

only to the extent that the universe could be exhausted by the universe of just one big bang, since all else is a conjecture. What about the general causal structure of this big bang universe taken as such, given the possibility of big crunches and further bangs? If the present big bang universe is just one such in an infinite sea of universes, what would be the most general structure of causality in such a universe? Would causality be thorough or partial in all these cases, or only in one or a few of them? This type of questions would presuppose that we deal first with the case of the big bang universe and the thoroughness or otherwise of intra-cosmic causality.

The treatment of intra-cosmic causality of the big bang universe should answer also questions that issue from the above possibility. But, the question, 'To what extent can the outward physical causal influence from the big bang universe of ours go on to other universes of the multiverse?', is answerable only if the extent of influence of intra-cosmic causal effects of the matter-energy within one and the same universe is understood. To have material causality engage infinite time to traverse infinite space and time to influence infinite number of parallel universes in the multiverse is a contradiction in terms. For, there is only finite causal influence at a finite mutual distance. Otherwise, the intra-cosmic causality of one big bang universe would have to depend on an infinite number of external causal strains, which cannot ever be materially infinite, given the spatiotemporal

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big bang theory: (1) The conclusion of acceleration of galaxies, from the fact of redshifts of galactic radiation that reaches us, shows an expanding universe, and a backward reconstruction from it shows at least one big bang. This is a causal reconstruction. (2) The theory predicts that 25% of the total mass of the universe is helium formed during the first few minutes (or much after the inflation scenario took over) after the big bang, which agrees with experimental facts at least in the known parts of the universe, the explanation of which has expressed things causally. (3) Most important of all, the presence of the remnant cosmic background radiation, predicted earlier by theoreticians and fortuitously discovered by Arno Penzias and Robert Wilson in 1965, reconfirmed by the 1989 Cosmic Background Explorer (COBE) and announced in 1992, shows the big bang as its source. This too has been conceived as a causal residue of the big bang. After about 300, 000 years of expansion, the universe cooled to a temperature of 6, 000 K (somewhat the surface temperature of the sun), at which temperature individual electrons and nuclei formed stable atoms without net electric charge. Electrically neutral atoms would not interact strongly with electromagnetic radiation, and so, the background radiation went undisturbed. John Gribbin, *Companion to the Cosmos* (Hyderabad: Universities Press, 1996), s.v. "Background Radiation," 48.

causal possibilities within a given finite big bang universe. Thus, a material causal influence traversing an infinite time with respect to every bit of an eternally pre-existing finite universe or infinite multiverse becomes redundant. Hence, what is possible is an ever-growing causal horizon.

Thus, I find certain causal conceptual discrepancies in the assumptions about the beginnings of the big bang universe and other theories that absorb the concept of big bang into their theoretical structure, which we shall discuss in this essay. Here I restrict myself to just paving the way for showing that the big bang universe of can only be thoroughly causal. Whatever I think are philosophically difficult to accept from within these existing theories seem to me to bear from certain logical, mathematical and physical assumptions built into the fields of success of application of the big bang theory by their very nature, some of which have gone into the foundations of other theories too.

So, I take up the assumptions and results of the big bang theory, and proceed to argue that certain general causal and acausal conclusions of the big bang group of theories do not follow, and that some other conclusions are only part of other larger ways of solution of the causal / acausal impasse. It is essential to show that the so-called mathematical and physical singularity before any big bang and before any black hole explosion,[7] if they are to be considered acausal, is only a mathematical extrapolation and approximation, and a physical containment of the play of infinities and zero-extension point instances[8] in physical theory.

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[7]"In order to set the scene, Bardeen, Carter and Hawking had, by the early 1970s, arrived at a number of important results about the nature and properties of black holes. These can be summarized in the four laws of black hole mechanics: (1) A quantity called the surface gravity κ_h is constant over the surface of the black hole. (2) The change in mass due to external actions is given by $dM = (\kappa_h)\ dA\ /\ 8\pi G$ + work terms, where A is the area. (3) The area of a black hole always increases. (4) The surface gravity cannot be reduced to zero." Moss, *Quantum Theory, Black Holes and Inflation*, 1-2. The surface of the black hole is the event horizon where escape velocity is the speed of light and, so, deeper from within the black hole, from beyond the event horizon, one expects absolutely no escape, and never more! This, mixed with our suggested solution for the singularity problem in this essay, points to the fact that there is something wrong with the limiting of possible velocity as the speed of light.

[8]An interestingly disparaging remark by David Bohm about the theoretical inconsistencies in Quantum Mechanics could be considered as extendable to

Problematizing of infinities in the black hole singularity and in the big bang singularity is not made up without reason. It is mathematically a need, based on the physical impasse created by the mathematical concept of continuity. It is also a philosophical issue because it tells upon our very understanding of the 'causal horizon' of the universe, and not because of a need to bring out some ontological conclusions out of the dilemmas that involve infinities and zeros in the big bang.[9]

Cosmology, the calculation of the speed of light in the Special Theory of Relativity, etc. Here, Bohm discusses a theoretical aspect of the crisis in quantum mechanics and relates it to the point instance concept: "When one applies the existing quantum theory to the electrodynamics of 'elementary' particles (such as electrons, protons, etc.), internal inconsistencies seem to arise in the theory. These inconsistencies are connected with the prediction of infinite values for various physical properties, such as the mass and the charge of the electron. All these infinities arise from the extrapolation of the current theory to distances that are unlimitedly small. Among the things that make such an extrapolation necessary, one of the most important is the assumption, which seems to be an intrinsic part of current theories that 'elementary' particles, such as electrons, are mathematical points in the sense that they occupy no space at all. On the other hand, in spite of many years of active search on the part of theoretical physicists, no way has yet been found to incorporate consistently into the current quantum theory the assumption that the electron occupies a finite region of space. While it has been suggested that perhaps the infinities come from an inadequate technique of solving the equations (i.e., perturbation theory), persistent efforts to improve this technique have not yet produced any favourable results, and indeed those results that have been obtained favour the conclusion that basically it is not the mathematical technique that is at fault, but rather the theory itself is not logically consistent." David Bohm, *Causality and Chance in Modern Physics*, London: Routledge, 2008, 121-122. In a footnote for this passage, Bohn adds: "Most of the difficulties originate in connection with making such an assumption consistent with the theory of relativity."

[9]For example, Moss says: "In order to qualify as a black hole the surface has to divide spacetime into two regions as it evolves in time. Light from the outer region can escape to infinity but the light from the inner region is trapped. The event horizon between the two regions is generated by a special set of null lines or light rays whose curvature determines the surface gravity κ_h. For a Schwarzschild black hole the surface gravity is $\kappa_h = 1 / (4GM)$." *Quantum Theory, Black Holes and Inflation*, 1-2. If, by the Schwarzschild theory, the light from the outer region of a black hole in a galaxy can, at least mathematically, "escape to infinity," then, the so-called sole big bang universe could physically free into infinity the radiation from within the outskirts of its massive central black hole, just after the central black hole exploded! This poses questions at the foundations of the extent of influence of gravitation in the big bang universe.

The causal horizon of the universe refers to the spatiotemporal horizon of causal events in the universe, (1) which lies ever beyond the immediately given causal processes and (2) within which alone we can bring in a systematic explanation of the difference between (a) the concept of strict mathematical continuity in the infinitesimals that are used to describe the processes in the universe and (b) the concept of the actually spatiotemporally discrete nature (discontinuity) of causally interacting finite bodies within a specific spacetime – without actual recourse to wider causes. The merit of the concept of causal horizon that brings mathematical continuity and spatiotemporally physical discreteness to bear upon particular causation is that causal horizon always leads causal explanations far beyond their immediate present, into theoretically / mathematically including, in the past, all that have contributed to give rise to the phenomenon in question. Hence, the causal horizon of anything is whatever has gone to contribute to its causal formation. What is missing or mistaken in a physical theory can always be supplied if we dig up the causal ramifications of elements possibly involved, all of which are already admitted by the horizon.

Now, the dilemma of continuous relation between infinities and zeros in macro-physics blocks the concept of causal horizon. When, in the graph of the four-dimensional spacetime of a black hole, the process of increase of density is charted against the process of decrease of volume, by a one-to-one correspondence between the set of progression of possible values of density (which increases by rational values of ever greater nominators) and the set of retrogression of possible values of volume (which decreases by rational values of ever smaller nominators), then we end up with the possibility of infinite density as against zero volume. It is most interesting to note that in singularity, there is an infinite gulf, where only absolute discontinuity from the previous and the later physical states and, thus, absolute acausality apply boundlessly. It is not merely a mathematical inevitability in the case of cosmology. It is a causal-theoretical abyss into which most astrophysical cosmologists have fallen, escape from which is feasible neither by physical solutions nor by mathematical solutions, but by fixing the limits of applicability of mathematics to physics by use of the Law of Causality, with clarity in the concept of causal continuity.

Thus, one wonders what is missing in the physical theory when, say, in the case of the volume-mass ratio in the singularity, ever smaller

infinitesimals are permitted to be on a one-to-one correspondence with ever growing finite values, in asymptotic approach, causing the following physico-mathematical dilemma: "Has the black hole a size? In one way, yes; in another way, no. There is nothing to look at."[10] Further, (1) as in such a classical prediction adhering to the mathematical dictate of asymptotic approach, only infinite density could be achieved in a finite time of implosion, and (2) as expansion after a collapse into such infinite density is impossible in the classical Einsteinian theory and in the geometry, the physicist looks for missing effects or quantities, but "[n]o one knows a cheap way out. The infinity is infinity so long as one stays within the context of classical theory. Infinity is a signal that an important physical effect has been left out of account."[11] If the massive black hole at the centre of the universe and elsewhere had to have infinite density, with an infinite curvature of space, it was suggested by Khalatnikov and Lifshitz, during the 1965 London International Conference on Gravitation Physics, that "perfect symmetry" of the sphere of the black hole was a must. But,

> Penrose, Hawking, and Misner ... gave compelling arguments why minor departures from sphericity will not save the system from being driven to a singular state. Subsequent to the conference, Hawking, Penrose, and Geroch, working within the framework of Einstein's theory, giving up spherical symmetry and accepting one or another set of simple conditions on how the motion starts, have proved that a singular condition inevitably develops. Zel'dovich has arrived at the same conclusion in another way.[12]

Clearly, perfectly spherical symmetry in cosmological processes is *non grata*, and any geometry that follows or ends in perfectly spherical horizons even at the most extreme ends of a process is unfit for physical application. One believes merely in the mathematical formalism over limits of physical possibility and applicability!

One may now say that the solution hides in Quantum Gravity in that, if the quantum of action were applied at the "moment" of creation, at the

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[10]John A Wheeler, *At Home in the Universe*, New York: Springer Verlag, 1996, 59.

[11]Wheeler, *At Home in the Universe*, 56. In fact, the infinity here is no signal of having left an important effect out of consideration, but the signal that, due to lack of limits to application of mathematical infinities and zeros to physics, a physical infinity and a physical zero result!

[12]Wheeler, *At Home in the Universe*, 57.

singularity of black holes and at the singularity of the centre of the universe, then everything will be all right! Unless it all serves to de-sphericise the shape of the event horizon[13] – which Quantum Gravity cannot do, due to lack of tools and since it works within the framework of the concept of speed barrier of light that permits the Schwarzschild radius to forbid forever any escape of anything from the surface of the black hole – one cannot imagine a solution. Still another solution I would visualize is that of showing that the spin of the central black hole of the universe that is supposed to be in singularity is not infinite after all! Only infinite spin could hold infinite mass together, and only infinite spin would make the centre absolutely spherical. This shows that something physical is missing or mistaken in the fundamental theory, due to lack of delimitation of mathematics to physical consumption.[14]

3. Spatiotemporality of Macrocosmic Causality in the Singularity

Without prejudice in favour of what may emerge from our work as a theory more general than the present limited big bang theory, let us accept the essentially general sense of the details of the big bang theory as such, as developed by the pioneers and by later astrophysicists and cosmologists. Before we point out the problems in the theory of singularity, we put down some commonplace details of the big bang theory and move forward with the vantage thus obtained. This will prepare us to accept the causal horizon as the foundation to draw some causal horizonal instances that may later point to the fragility of any absolute commitment to some of the

[13]An event horizon is "the imaginary surface surrounding a black hole on which escape velocity is equal to the speed of light. Within the event horizon, the escape velocity would be greater than the speed of light. Because nothing can travel faster than light, nothing (not even light) from within the event horizon can cross this surface and escape into the outside Universe... But there is nothing to prevent matter or radiation from the outside Universe crossing the horizon on its way into the black hole; it is not a physical barrier like a wall." John Gribbin, *Companion to the Cosmos*, s.v. "Event Horizon," 168-9.

[14]I believe that the more fundamental solution that might result in de-sphericizing the primeval fireball and showing that the spin is finite lies in lifting the speed barrier set in the speed of light and in fixing the extent of applicability of mathematics to physics – of which we concern ourselves only with the latter. These do seem capable of de-sphericizing the event horizon of the black hole at the centre of the big bang universe, because they work things out from the very Law of Causality. Questioning the extent of applicability of mathematics to physics here perhaps suffices for getting a working solution.

particularist causal assumptions, details, and conclusions of the big bang theory.

Due to the fact that Riemannian geometry and any four-dimensional geometry will need a frame of reference with its origin as zero in space and time in order to deal with the universe, and due to the "numerics" of singularity applied to the primeval universe at the zero time considered as arithmetically necessary for any mathematical explication of the universe, we are compelled to say that, before explosion, the then-size, -time, and -radius of the primeval universe had to be zero; and, by inverse proportionalities, that its curvature, temperature, and density had to be infinite.[15]

But it is straightforward that infinite time should already have elapsed between this infinite-density state and the actual big bang. This fact produces a contradiction in the singularity requirement! Let me explain this claim further: The singularity is mathematically the ideal Euclidean point at which there are no more dimensions, like at the origin in the three-dimensional and four-dimensional plains. This point is, in fact, only a convention with respect to the spatiotemporal circumstance, since we cannot start the measurements at the three or four coordinates from infinity. The conventional point is physically non-actual, although mathematically it is a convention. Conventions need not as such represent but only symbolize some aspects of reality.

So, to bring this conventional point of the beginning of the universe into actuality by a bang of infinite dimensions, either infinite space and time has to elapse (since this point had to contain all that the universe had), or the primeval ball ebbed in acausally from nowhere, or an Unmoved Mover God created it just once, once for all! This situation is brought in by the arbitrary choice of the origin of the mathematical description. This physical paradox of application of mathematics having been spelt out at the very outset, it is important for us now to go into some more essentially general cosmological details of the big bang theory, to be able to argue further in favour of the thoroughly causal horizon of the big bang universe. This would tell us that infinite density at the central black hole of the universe is a contradiction.

Our disjunction is: Will the big bang universe go on expanding forever into the distant future? Or will it stop expansion, allowing implosion of the whole matter into the central black hole and, thus,

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[15]Pagels, *Perfect Symmetry*, 250.

continuing to a finite or infinite number of oscillations?[16] But will there be an end at all for the expansion of the big bang universe as a result of the mathematically presupposed infinite density and zero spacetime in the singularity? For this, we need an answer that settles the causal horizon of the big bang singularity. So our concentration is on the big bang singularity.[17]

For pragmatic purposes, propagations (gravitational and also electromagnetic or other forms of non-gravitational propagations that are produced) at the big bang moments may be assumed to take an almost Euclidean, close to flat spherical geometry of straight line propagations from the outskirts of the universe, determinable at any given time, measured with respect to its centre, although these are still not conceivable as being beyond the gravitational influence of the centre of the universe in question. But I would argue that, if infinite matter has to be contained in this universe, its spherical geometry could not be absolutely flatly Euclidean, since infinite matter can never be contained in a finite spacetime implying finite volume, though it can be assumed to follow a geometry close to flat spherical geometry. Only infinite matter could have made it irreversibly of infinite spacetime curvature. This, however,

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[16]Here we do not have to bother about cosmological defect-formation due to sharp phase transitions and symmetry breaking in the overall history of the big bang universe, because what we deal with are much wider phenomena – very much external to the inner happenings of matter content in the universe – all of which are aimed only at a general causal inquiry for which we do not use direct causal results from the formation of surfaces, lines or points resulting from cosmological defect-formation. Famously, these phase-transitional defect-formations are domain walls, strings, and monopoles. Whatever the causally cosmological results we need for our general causal inquiry of the way the phase transitions affect the overall picture, these results are already causally included in what we understand as gravitational, electromagnetic, and other propagations at the outskirts of the (total/island) universe. Our question is more general.

[17]Similarly, General Relativity too may have something to do with our inquiry, but only very marginally, in that the physical state at the very external outskirts of the universe we are planning to discuss is already very much theoretically aloof from the influence of the very consequential conclusions of General Relativity. To put in gist my argument against including the causes of structural defects and effects of General Relativity in our general causal inquiry, it suffices to say that these are not essential since what we finally consider are only (1) the extra-big-bang causal structure derivable from intra-cosmic causation and (2) the widest energy propagations beyond the matter-concentrations of the overall universe.

requires infinite spacetime at the centre of the universe. That is, an infinitely dense finite centre is a contradiction. Hence, the macrocosmic causality within any finite universe will be also finite and spatiotemporal.

4. Causal Thoroughness from the Big Bang Causal Horizon

Now, one might argue that even mathematics breaks down at singularities where the mathematical size of the universe is zero and that, therefore, admitting the temperature and density of matter as infinite at singularities is unavoidable. This is admittedly begging the question or, better, an Anselmian "ontological argument" for the existence of a supposed concept of a mathematical perfection. This perfection is constituted by (1) the conceptually (mathematically) induced and trans-infinitesimal jump of matter into zero spacetime and physical existence therein, which was only assumed, for convenience, to be the geometrical origin of spatiotemporal magnitudes within the implosion process of a finitely spatiotemporal big bang universe and (2) the resultant conceptually (mathematically) infinite density, pressure, etc., that are mathematico-ontologically concluded to be existent in physical / material actuality.[18]

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[18]To draw parallels between the Ontological Argument and the mathematical argument for the existence of singularity, here is a recent rendering of the ontological argument, by Yujin Nagasawa: "[I]t is indeed *im*possible for atheists to think of a nature that is greater than a-nature-than-which-no-greater-can-be-thought. Therefore, the argument goes through and successfully yields the conclusion that a-nature-than-which-no-greater-can-be-thought must be instantiated in reality." Yujin Nagasawa, "Millican on the Ontological Argument," *Mind*, 116 (October 2007), 1036. Peter Millican, in his reply, quotes these statements and shows why the second statement does not follow: "Nagasawa, on Anselm's behalf, rejects the principle of superiority of existence and suggests instead that the nature <God>, even if uninstantiated, should be taken to be greater than any other nature, achieving a level of greatness that could be exceeded only if it were itself instantiated. Thus the highest possible level of greatness is that of an *instantiated* <God>, and the next highest is that of an *uninstantiated* <God>." For this reason, "... his 'Therefore' here is a *non sequitur*. True, the Fool can no longer escape contradiction in the way that my previous article highlighted: that is, by taking advantage of PSE [principle of superiority of existence] which allows <God> to be – without contradiction – exceeded in *actual* greatness." Peter Millican, "Ontological Arguments and the Superiority of Existence," *Mind*, 116 (October 2007), 1050. In this regard, it is impossible to first show that the singularity that is had in mathematics (representing mind) is already instantiated (representing physics). Without that one cannot say that, since the idea in mathematics is that of a perfection, it has to be instantiated!

It is due to the conceptually mathematical generalization of the concept of number that the consequent infinitesimal process is made to occur in the big bang black hole. Thus, one unwarrantedly takes for granted the conceptually (mathematically) resultant name 'singularity' given to the hypothetical zero spacetime and the conceptually (mathematically) resultant infinite density, pressure, etc., together, as representative of an actual physical / material infinity of mass at zero spacetime / volume, merely because of a certain a-physical (because the process of making values concomitantly approach zero and infinity is not physically instantiated, but only conceptually generalized and dubbed / named as 'zero' and 'infinity') but mathematically proportional (due to division by zero or division of zero) necessity; one would argue that, since it is singularity, it should also possess the very geometrically hypothetical zero spacetime and the rationally impossible infinite mass and density! Then, the cosmological conclusion of this mathematical experience in physics is that we would have to look for further causal structures emerging out of the very finite big bang universe considered, for us to be able to look into the possibility of there ever being an infinite universe!

We have discussed the mathematical-cosmological paradox in singularity. It commits a species of the ontological "fallacy of whole and part" in the field of applicability of mathematics to physics. Let me call this species "the fallacy of identification of reason and mathematics" and try to spell out the ontological problem in it. Reason is the whole and mathematics a part. Here, reason includes other actual forms of logic in addition to mathematics and, further, also includes a sort of systemic logic that goes out from every elementary point of information spirally ever wider to other wider logics that include many such spirals only to form other meta-logical strains acceptable to reason. The method of reason is logic, to which belongs mathematical reason.

The fallacy arises from the fact that, unconsciously, the fundamental algebraic and geometrical entities (which are transcendental entities with foundation in actuality) are made to formally reflect as equivalent to each other and one begins to get such mathematical objects materially identified with physical objects (which are transcendent entities in that they are transcendent to anything different from themselves), instead of mutually imperfectly echoing the body of mathematical theories and the body of physical theories through the interplay of each type as much as possible within themselves by use of the two types of absolutely dissimilar but

theoretically compatible objects. Thus, the source of the fallacy is that the function of mathematics as economizing thought is substituted by reflecting thought as such, here scientific thought. Thus, reason is substituted by mathematics.

To do away with this fallacy, we need a thoroughly causal manner of procedure (beyond the fields of description adopted in the Relativity Theories) in spatiotemporal description in cosmology so that causal necessity (all other forms of necessity have to correspond with this form), yielded by the immediate and more general causal horizons of the phenomena, takes over and mathematically revamps not only the singularities that arise in mathematical description of the big bang universe/s but also the semblances of mathematical singularities of centres of every celestial body. I would like to moot this possibility as a great promise in cosmology, in general, and the physical sciences, in particular.

Let me elaborate on the area in which we need a shift of attitude in the way of application of mathematics to general cosmological processes, in order to avoid the ontological fallacy of whole and part, just mentioned, in the application of mathematics to cosmology / physics. The problem in black hole singularities and in the singularity of the pre-primeval big bang universe is that a finite time lapse is mathematically projected by way of obtaining the then-density as the inverse of infinitesimalized space (and time) at the singularity phase. The mathematical tendency to find the exact inverse of the infinitesimal space would be to do away with causally infinitesimalizing the processes in matter-energy in space and time at the geometrical origin of the big bang and irrationally finding its limit as zero, rather than 'revamping' at every turn from big bang to big crunch and vice versa. Revamping of black hole mathematics from the so-called mathematical singularity of the big bang by way of causal horizonal introduction of the counter-process to the big crunch stage is reasonable, if it is based on the finiteness of the total horizon within the reach of that universe-centre or minor black hole.

This is possible only if everything happening within the actually finite-density big bang universe is seen to be causally reversible due to the impossibility of an infinite causal continuance of the implosion process in a physical universe. The impossibility of infinite causal continuance of implosion has its reason not merely (directly) in the physical nature of the universe, but in the finite mass of the big bang universe and the finite amount / extent of possible gravitational propagation. Finite mass does not initiate an infinite process of compression. This is so because, if every

physically almost infinitesimal element were to permit further compression unto zero volume, an infinite time had to elapse, and this would mean that absolutely no repulsive causal resistance is offered by these particles to other particles getting closer to it. If it had to be so, there is no reason why we find today such causal repulsive resistance! The key to the solution rests perhaps in offering a maximal repulsion ratio with respect to every stage of every big bang.

That is, every infinitesimal-point-instance that seems to mathematically represent particles in the universe has to be originally considered as absolutely two-way causal, as a finite mass of matter does not causally initiate an infinite process of condensation / implosion. Hence, a physical reversion of the gravitational process is really possible, without which an external cause will have to be drawn in, in order to keep the mathematically infinite process of implosion from going! Matter in the universe, in all its imaginable infinitesimal structures, is thoroughly two-way causal, insofar as no infinite matter-energy can be amassed around a point instance in a finite spacetime. Again, doing away with infinitesimalizing causal condensation and causally avoiding its zero-limit have to do with a process of inculcating and maintaining positive space and time into the process. This is causal in every bit of the process, since every bit that is involved resists and attracts other bits, and this is already a two-way causation. So, pure spatiotemporal relativistic description needs only to either introduce the repulsion factor or initiate it at the very inception in terms of an attraction-repulsion factor.

The moment we take the big bang as the geometrical origin (zero) of the four-dimensional process and the physical event horizon, we are again stuck with attempts to avoid bringing in positive space and time at the origin, thus, having conventional mathematical assumptions determining and infinitizing the finite nature of causation by use of the zero at the geometrical origin of the spacetime and reach the conclusion of infinite content in the finite big bang universe. Infinitization of a finite quantity by use of the mathematically possible zero-limit of volume yields the limit of density, mass, etc., as infinity. One forgets here the fact that the big bang universe presupposes only finite, positive time and space. Negative curvature of spacetime is reversible by the repulsion factor that the causal horizon introduces.

This need not mean *ipso facto* that the universe is just the big bang universe of ours, which let me call 'island universe' in case it is part of an

infinite-expanse multiverse. Any fixed origin geometry in a multiverse is left to follow only the pragmatic way of fixing the island universe as the only universe. This has been the ultimate fate of all applications of mathematics to physics. If there is infinite number of island universes, the spacetime of each finite set of them would overlap, and we need a different geometry than what we use in General Relativity. This is a fresh area of mathematical application in cosmology to be worked afresh. Infinitization of the central black hole goes against this possibility. This is clearly a problem of connection between mathematics and physics. Since this happens due to mathematics' unwarrantedly ubiquitous and fundamentalistically generalized application to the condition for the possibility of all physical beings and to the discourse on them and since the philosophies of physics and mathematics treat of the applicability of mathematics to physics, this infinitization is a philosophical problem of physics and mathematics as well. Since the exact structure of the problem has for its context the time prior to the big bang phase of the universe, it is a problem of philosophical cosmology too.

Let me point out also that the lack of any ideal-absolute applicability of mathematics to physics and cosmology need not have anything to do with the now well-founded fact of the absence of an ideally and absolutely axiomatic well-founded mathematics. This is so because mathematics, although derived from physically rational imaginations of bio-physical beings, need not always have to do with actual physical / material possibilities (e.g., topology treats of the quantitative aspect of specific qualities), and instead it may be many a time also of simple, abstract, and non-realizable possibilities of quantities.

Let us suppose for argument's sake that, as is ideally the case, a certain branch of mathematics, say, number theory, is absolutely well-founded on an absolutely true system of axioms. This would produce just another form of number theory which too has zeros and infinities that do not have an exactly empirically verifiable number of counterparts. If (1) an empirically verifiable zero number of objects / quantities implies, by an inverse proportion, an empirically unverifiable infinite number of objects / quantities and (2) an empirically unverifiable infinity implies an empirically verifiable zero, then too we have the absence of absolutely direct compatibility and reflexivity between mathematical objects and physical objects. So long as this remains a fact without contrary choice even with respect to an ideal mathematical theory which, hypothetically, is axiomatically absolutely well-founded, we are still left with the absence of

any direct grounds for correspondence between mathematical objects and physical objects. So, whether mathematics is axiomatically absolutely well-founded on firm axioms or not, we have no absolute correspondence between mathematical theory and physical theory.

At the side of application of numerical values and mathematical procedures to the case of general cosmic processes, therefore, we shall need an inbuilt technique that does not infinitely go on infinitesimalizing space and time at the level of the physical processes in the big bang. We need this technique to permit the negative side of the number (time) line to constantly extend behind the temporary origin, if need be, until the mathematical reconstruction of the physical process is set on a continuous scale of positive quantities.[19] This would ensure the decisive place of general causal horizons in normalizing the place of mathematical applications in physics and cosmology.

Another way is to introduce the repulsion rate constant, either towards the end of the implosion phase, or at the very start within the ambit of a two-way (attraction-repulsion) rate constant – here too under the guidance of general causal horizons. The general causal horizons are to guide them, as without them the two-way process would be equal, giving rise to a mechanical universe that winds and unwinds.[20]

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[19]Einstein's equations and his picture of classical spacetime, with non-negative energy densities, maintain the unavoidable possibility of singularity at what we call today the Big Bang origin of the universe and the divergence of tidal forces (Weyl curvature) into infinity. Penrose, *The Road to Reality*, 713. It is evident that it is the mathematically unavoidable zero spacetime and its direct inverse, the density infinity, that are implied herein. This is the reason why cosmologists have not been able to differentiate between (1) the actual physical impossibility of access of information from the central core [for that matter, even from the spacetimes slightly apart from the core] of a black hole and (2) the so-called rational impossibility of access of matter / energy to the core of the black hole! Penrose refers to what amounts to the latter assumption (in fact, a result of the uncensored application of numerical zeros and infinities in cosmology), that is, "the singularities will always be so hidden," which is called 'cosmic censorship'. Penrose, *The Road to Reality*, 714.

[20]Thermodynamic considerations would also form part of this phase of determination and adequation of applicability of mathematics to physics. Now, the mathematical way in which this has to be effected and given shape to by necessary changes in the non-Euclidean geometry, differential geometry, topology, and the related mathematical physics, remains to be cogitated by mathematicians and mathematical physicists, not too much by philosophers of mathematics and physics. Suffice it to say that this is possible only if we realize, by considering the results of

This does not mean that we take the universe as necessarily extending beyond the big bang universe. We have made it rationally possible for the universe to be so if it has been extending beyond, by insisting on finite causality exerted by finite mass within its gravitational reach. It remains to the purely rational aspect of astrophysical cosmology to determine if this is the most probable case by reason of the very internal causal structure of cosmic physical processes – which is what I have tried to show in this paper as causally thorough. In any case, a breakdown of the presuppositional categorial Laws of Physical Ontology or of all known laws of physics or of all mathematics at the 'singularity' is now out of the picture. In short, if we are safe in insisting that the alleged infinite density of the pre-big-bang universe in finite spacetime is impossible within the actual status of the causal horizon, it is also easy to avoid mathematical inconsistencies and free ourselves of problems of a breakdown of physical and mathematical laws. Hence, it is now easy to conclude that there are only physical approaches to mathematical singularity at the black holes of the centre of our universe / island universe and of the galaxies.

A related issue of mathematical physics and philosophical cosmology to be kept in parallelism with the causal horizon problem of the big bang universe is that of the causal horizon of (the causally controlled and regularized shape) of curvature of the arrow of specific time in a few other broader cases of the structure of the universe: (1) in case of a singular universe that goes on banging and crunching eternally in oscillations, and (2) in case of a universe that is infinitely spatiotemporal from the point of view of every possible geometry, even from that of Euclidean geometry, i.e., containing an infinite number of island universes, each of which is in a finite number of oscillations, of which only a finite number can be in mutual causal relationship at once. This would be the subject of another layer of investigations one should undertake. I believe such inquiry would give rise to a General Gravitational Coalescence Cosmology that might do away with the cosmological and mathematical glitches in one stroke, of course, after much causal horizonal research on the possible ways of origin and evolution of the universe.

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some of the preceding sections, that the geometrical origin of description of each big bang epoch is to be set on a continuously positive number line that, if isolated, has a finite physical / material origin, which but happens within the continuously variegated and ever widening quantities of available temporal extensions of matter.

5. Conclusion: Prospects of Causal-Horizonal Research in Cosmology

As we have so far seen, the bizarre fact about the concept of singularity is that the mathematics of the singularity can work neither for the "moment" of singularity nor any other time that follows or went before. So, as I have attempted to show philosophically, that every iota of activity in the primeval universe had to be thoroughly causally continuous as determined from the respective, more general, causal horizonal possibilities. Now, if this is granted, it is straightforward to conclude that the universe is thoroughly causal during, after, and even before the big bang, and no acausality seeps in from somewhere.

This facilitates concluding, at the realm of extra-cosmic causal structures (at the level of possible more general causal horizons yielded by a multiverse) derivable from intra-cosmic causation, that there are gravitationally relatively less controlled energy propagations beyond the total matter-concentration of the overall big bang universe. This is clearly so because (1) when there is no infinite time elapsing, as we have shown, between the so-called singularity and the actual big bang, we have only a finite time between them and (2) during the finite time there is no infinite gravitational control over the energy dispersed at the outskirts of the primeval universe, prior to, during, and after the big bang, and most probably also on the energy released at the farther outskirts of the finite big bang universe. So, as a result of causal horizontal research, we need to go either for an oscillating finite universe, in which case the whole matter would sooner or later be exteriorized in energy form in a finite number of oscillations, resulting in a dead universe where the question why it could not be yesterday or the day before is unanswerable; or else, we need to go for an infinitely oscillating universe which goes on augmenting its causal horizon. The future prospects of causal horizonal research on the cosmos seem quite promising.

If we consider the oscillating universe with an eye to its gravitational and other forms of causal propagation of energy, we may have to consider other forms of theories of the origin and evolution of the universe, too. A detailed consideration of forms of dissidence against the big bang theory is sure to yield more experience and better ways of formulating the discipline of causal horizon with its direction of causal thoroughness and its philosophical, cosmological and ontological implications. At the build-up of so much of consideration of possible layers of the causal horizon of the universe and/or of the multiverse – it being more reasonable to consider

the universe to be most probably as an infinite multiverse – we have to move in such a way as to come to terms with the general causal structure (whether thorough or otherwise) of the universe, i.e., from the inner causal thoroughness of the universe, and discover something slightly more wonderful than what the big bang theory, oscillating universe theory, etc., have offered. This could be done from the point of vantage gained in the present attempt and then we may show with further reasoning that the big bang universe had to be, in any case, causally thorough.

In short, cosmologists have not much taken up the field of causal horizonal research with respect to various theories of the origin, evolution and end of the universe. In my opinion, such a search, particularly by adherence to the fundamental principles and possibilities of general rational and ontological presuppositions of physics, would yield much that is desirable in astrophysical cosmology and further the prospects of philosophical cosmology. This might even revive philosophical cosmology from philosophical attempts to adumbrate it under the discipline of philosophy of science. I would, thus, propose causal horizonal research as a new viable path for the development of philosophical cosmology firmly based on the experimental and theoretical possibilities of astrophysical cosmology.

Do all these moot the possibility of external causation that shows forth from the particularistic causal mess of intra-cosmic causation in the big bang group of theories? Perhaps, as the only way, there exists the possibility of continuous creation that results from a causal horizonal consideration of the various theories of the universe, given at any instance any sort of theory of origin of the universe. I spoke so far of the physically mandatory inner-universe causality, but suggest in the end that thoroughness in inner-universe causality may show extra-universe causality, because causation cannot but be thorough, without which both the inner- and extra-world causalities would incur the irrationally infinite gulf and, thus, also lack rational continuity. This is not a traditional argument, I agree. There may, however, be cosmologically acceptable ways of showing it. I would call this new possibility as General Gravitational Coalescence Cosmology. We need, then, only show what is meant by freedom within the ambit of causal thoroughness.