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Ātman, Quasi-Recurrence, and *Paticca Samuppâda*

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Extended Abstract

Traditional Indian notions of self begin with the notion of *âtman* and the related doctrine of *moksa*. Because this doctrine is so central to Indian tradition, its study ought to be a key aspect of the PHISPC project as Daya Krishna has been emphasizing over the last decade. Notions of self, and the underlying time beliefs, also relate closely to values, as I have argued elsewhere, so a study of this notion is imperative also for any project which seeks to examine and document values in Indian traditions.

I begin by reiterating an argument that I first put forward 23 years ago: the notion of *âtman* in Indian tradition is located in the context of a quasi-recurrent cosmos; accordingly the notion is a *physical* and refutable one. Quasi-recurrence is not trivially refuted by present-day physics; indeed, according to Newtonian physics and relativity (phase flow, geodesic flow), and also according to quantum mechanical and stochastic (Markovian) evolution, under certain rather general conditions, recurrence must occur with probability one. It is, however, not known whether these conditions, in fact, prevail.

One may understand as follows why this notion is today regarded as metaphysical. A natural translation of *âtman* is "soul". This translation would have been accurate with the notion of the soul in early Christianity, where a very similar notion of quasi-recurrence prevailed, and was championed by Origen of Alexandria who asserted in *De Principiis* that this (i.e, essentially the doctrine of *karma*) was a demonstration of God's commitment to both equity and justice. After church and state combined, Augustine, Jerome, and Justinian denounced Origen (for political reasons relating to rejection of "pagan" Neoplatonism and its championship of equity) and substituted quasi-recurrence with the ad hoc, politically convenient but physically indefensible idea of resurrection, or apocalyptic time. This successful attempt to transform values incidentally made the Christian notion of soul metaphysical, and it has remained since then as a prime example of metaphysics in Western philosophy. The two notions of self—*âtman* (based on quasi-cyclic time) and soul (based on apocalyptic time)—should, therefore, be clearly distinguished.

Further, ever since Augustine, quasi-recurrence has been persistently confounded with "eternal return" in Western tradition, even by people such as Nietzsche, Mircea Eliade, T. S. Eliot, Karl Popper and Stephen Hawking. For a correct understanding of the notion of *âtman* and *moksa*, therefore, quasi-cyclic time, must

be carefully distinguished from supercyclic time, and the opinions of these and other authorities must be discarded.

Perhaps the most curious aspect of Augustine's enduring legacy and the resulting theological debate is the ability to be comfortable with two entirely conflicting time beliefs such as apocalyptic time ("determinism") and mundane time ("free will), and to use either time belief, as convenient! Such conflicting time beliefs persist in current Western philosophy:for example, the very criterion of refutability, which seeks to discriminate between physics and metaphysics is founded on mundane time, while physics itself uses superlinear time. Very careful thought about the underlying assumptions, including the assumptions about time incorporated into the grammatical structure of natural languages like English is, therefore, needed before arriving at any conclusions in the matter.

The situation is further confounded by the fact that Augustine's incorrect arguments against quasi-recurrence nonetheless continue to influence present-day physics, as in Hawking's singularity theory which adapted Augustine's arguments to closed time-loops or in the currently "standard" resolution of the grandfather paradox of time travel. Thus, the views of present-day physicists on quasi-recurrence and closed time loops are not necessarily a valid guide to the physical prevalence or otherwise of quasi-recurrence.

As I have argued elsewhere, disentangling this knotty situation requires first a reformulation of physics, along the lines that I have proposed. Secondly, it requires a reformulation of the criteria for demarcating physics from metaphysics, so that these criteria are not founded on assumptions denied by physics. Even with these reformulations, the factual prevalence or otherwise of quasi-recurrence remains an open question, though there remain no valid logical, physical, philosophical objections to closed time loops on any scale: microphysical, mesophysical, macrophysical, or cosmological.

While the above line of thought meets various known objections, in Western thought, to the notions of *âtman* and *moksa* it does not address the objections raised in Indian tradition. Thus, it should also be pointed out that though the Upanishadic notion of *âtman* comes at the beginning of Indian tradition, it was neither the universal nor the "predominant" belief in Indian tradition. From the earliest recorded Indian tradition, Lokâyata rejected quasi-recurrence and the notion of *âtman* on the grounds that it did not satisfy the test of *pratyaksa*, the only reliable method of validation that the Lokayata accepted. (This was in direct contrast to the rejection of the empirical as contingent, and the acceptance of logical deduction or inference as the sole method of proof in present-day mathematics.) Incidentally, it is little known but interesting that Pâyâsi actually performed numerous macabre experiments with condemned felons to test empirically the existence of *âtman*.

From a contemporary viewpoint, however, the most satisfactory and comprehensive analysis/synthesis is that of the Buddha. (a) The Buddha tackled the deeper question of persistence of identity under change ("recognition problem", which arises today e.g. in the development of speech-recognition software, which is conventionally required to understand as "same" two words articulated "slightly" differently). The Buddha adopted a different notion of self which makes quasi-recurrence irrelevant, for *âtman* in the sense of an unchanging essential "self" does not persist even unto the next instant. (b) Nevertheless, this is not quite a doctrine of flux, since the Buddhist notion of *paticca samuppâda*, which I have interpreted as incorporating history-dependent causation, differs from 'instantaneity' (or the belief that future and past are decided by the present, as in Newtonian physics, or in Einstein's misunderstanding of relativity theory). Accordingly, it leads to a different ontology, where one cannot assert, like Aristotle, that anything past has ceased to exist. This ontology is nevertheless not the same as McTaggart's B-series, for it is a key element of the Buddhist *dhamma* and notion of self, the very idea of *nirvâna*, that some aspects of the past may yet cease to exist! (c) Buddhist logic, which I have interpreted as quasi truth-functional logic, can

also elegantly handle problems concerning “self” in situations where Schrödinger’s cat is simultaneously both alive and dead or in macrophysical situations where Kip Thorne extends his hand through his wormhole (TWIST) time machine to shake hands with his younger self.

1. Introduction

Traditional Indian notions of self begin with the notion of *âtman* and the related doctrine of *moksa*. This is not the sole notion of self in Indian tradition, but it is central in the sense that many other schools of thought are better understood through the positions they have taken around this notion. Because this doctrine is so central to Indian tradition, its study ought to be a key aspect of the PHISPC project as Daya Krishna has been emphasizing over the last decade. Notions of self, and the underlying time beliefs, also relate closely to values, as I have argued elsewhere,[1] so a study of this notion is imperative also for any project which seeks to examine and document values in Indian traditions. In my opinion, it is lack of comprehension of this notion that led to the great difficulty that Hegel[2] had in comprehending Indian notions of morality.

The relation of the notion of self to the notion of time may not be obvious. To clarify this, I would like to begin by putting forward an argument I first put forward some 23 years ago.[3] Briefly the argument is that the notion of *âtman* is a *physical* (refutable, falsifiable) notion.

The notion is physical because it is located in the context of quasi-cyclic time, within the physical context of a quasi-cyclic cosmos. Briefly the idea is that the cosmos goes through a series of cycles. Each cycle is much like the next/preceding cycle, though not *exactly* like it. The analogy is to a sequence of days and nights:[4] each cosmic day is much like the preceding, but not exactly like it. Another analogy is to the Wheel.[5] (Thus, this notion of quasi-recurrence must be carefully distinguished from the "Stoic"doctrine of eternal recurrence, with which it has often been confused.) In this picture, people are repeatedly reborn in successive cycles of the cosmos. A person may change across cycles of the cosmos, just as a person changes from day to day (and, indeed, from moment to

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[1] C. K. Raju, "Reconstruction of Values: The Role of Science", in *Cultural Reorientation in Modern India*, ed. Indu Banga and Jaidev, Indian Institute of Advanced Study, Shimla, 1996, pp. 369–392.

[2] G. W. F. Hegel, *On the Episode of the Mahabharata known by the name Bhagvad-Gita by Wilhelm von Humboldt*, trans. Herbert Herring, ICPR, New Delhi, 1995.

[3] C. K. Raju, "Ancient and Modern Cosmology", Indian Statistical Institute, Calcutta, Discussion Paper, 1980. In: B. R. Nagaraja ed., Proc. of 10th Annual Meeting of the Indian Association of General Relativity and Gravitation, Bangalore, 1982, pp 84–104.

[4] Bhagvad Gita, 8.17–20. This echoes the notion found across the Upanisads and in the Visnu Purâna, as detailed in C. K. Raju, "Time in Indian and Western Traditions and Time in Physics", in D. P. Chattopadhyaya and Ravinder Kumar eds, *Mathematics, Astronomy and Biology in Indian Tradition*, PHISPC, New Delhi, 1995, pp 56–93.

[5] Svetâsvatara Upanishad 1.6. Trans. Swami Prabhavanand and Frederick Manchester, *The Upanishads: Breath of the Eternal*, Mentor, New American Library, New York, 1957, p. 118.

moment). But, according to everyday notions, there exists, or we fancy that there exists, an underlying continuity, which enables us to speak of a single individual changing from day to day. Analogously, we may speak of a single entity—the *âtman*—which continues unchanged across quasi-recurrent cycles of the cosmos.

The key point here is that this notion of *âtman* presupposes the context of a quasi-recurrent cosmos; and the notion of a quasi-recurrent cosmos is a physical one, since one can, of course, conceive of the possibility that the cosmos is not like that.

This Popperian notion of "physical" may not seem to be of much value:for what if such a possibility can be shown to be trivially false? Indeed, it is little known that Pâyâsi performed a series of experiments with condemned felons to test the possibility of life after death.[6] Today, however, we would regard such experiments as unsophisticated, and we would prefer to rely on physical theory. Does present-day physics trivially rule out the possibility of a quasi-recurrent cosmos?

To the contrary, the trivial falsity of a quasi-recurrent cosmos is ruled out by a result known as the Poincaré recurrence theorem. Though I am no great believer in formalism, the formal statement of the theorem is as follows.

Theorem. *Let* (X, μ, T_t) *be an abstract dynamical system, i.e.,* (X, μ) *is a probability space, and* T_t *is a group of automorphisms of* (X, μ)*, so that each* T_t *is one-to-one and preserves measure. Let A be any subset of X. Then for almost every* $x \in A$*, there exist arbitrarily large (hence infinitely many) t for which* $T_t\, x \in A$*.*

The above theorem says that in an abstract dynamical system, recurrence must occur with probability one (i.e., almost surely).

What does such an abstract dynamical system have to do with, say, Newtonian physics? The connection is provided in two steps. In the first step, we have the following theorem[7] which is an abstract version of a theorem called Liouville's theorem.

Theorem. *Let X be a compact Hausdorff space, and* T_t *a group of homeomorphisms on X. Then there exists a regular Borel probability measure* μ *on X which is invariant under* T_t*, so that* T_t *is a group of automorphisms of* (X, μ)*.*

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[6] For detailed references and interpretation, see C. K. Raju, *The Eleven Pictures of Time*, Sage, 2003.

[7] For a proof, see, C. K. Raju, "Thermodynamic Time", ch. 4 in *Time: Towards a Consistent Theory*, Kluwer Academic, 1994.

In the second step we connect Liouville's theorem to Newtonian physics. In Newtonian physics, the state of a particle at any time is provided by prescribing its position and momentum: thus, the state of a system of n particles is specified by specifying $3n$ position coordinates, and $3n$ momentum coordinates. Equivalently, the state may be specified by specifying a single point in $6n$ dimensional space called phase space. This phase space (with its natural topology based on the "Euclidean" notion of distance) provides the X of the theorem. (The state space is compact since the gas is confined to a box, and has finite total energy.) The next connection is provided by the existence theory of differential equations (Peano's existence and uniqueness theorem), which connects the state of the system at time 0 to a unique state of the system at any time t (past or future). This provides the group T_t. Identifying the conserved probability measure with the normalized volume of phase space, Liouville's theorem now appears in its classical form familiar to physicists: the flow in phase space preserves volume.

Lastly, we observe that the compactness places additional restrictions. In a finite dimensional space, a closed and bounded set is compact (Heine-Borel theorem). Thus, a gas in a box (with finite total energy) has a compact phase space, and the Poincaré recurrence theorem applies to a gas in a box. It tells us that: for a gas in an isolated box, every microstate must approximately repeat (to any pre-specified degree of approximation) infinitely often.

It may not be easy to isolate a gas in a box, but the cosmos is an isolated system. Thus, according to Newtonian physics, the cosmos must be recurrent if it is closed. (At the present state of cosmological observations, it would be rash to rule out such a possibility.)

The text-book way to bypass the conclusions of the Poincaré recurrence theorem is to say that the recurrence time is very large, even in comparison to the lifetime of the cosmos. This is a patently absurd argument: for the recurrence time can only be calculated under the assumption of "mixing" or ergodicity, and no one has the foggiest idea whether this assumption applies to the physical cosmos. (Few physicists even understand or care about what this assumption means, and, since mathematics is so explicitly divorced from the empirical, perhaps fewer mathematicians understand what it means for such an assumption to apply to the physical cosmos.) It would, in fact, be far simpler to arrive at a decision on whether the cosmos is closed than to arrive at a decision on whether the cosmos evolves ergodically. Thus, the assertion that the Poincaré recurrence time is larger than the lifetime of the cosmos is merely a text-book myth.

This text-book myth rests on two further simple-minded assumptions. The first is that there is an independent and external measure of time available, a clock which keeps ticking away, in the Newtonian imagination, regardless of the state of the cosmos. The

theory of relativity is based on negating this assumption, but this assumption is particularly absurd when the recurrence theorem is being applied to the entire cosmos. It makes no sense whatsoever to say that "the cosmos will stay for a long time in a state of thermodynamic equilibrium", for when the cosmos is in a state of thermodynamic equilibrium, there cannot be any possible way to measure time or anything else for that matter. There are further cultural presumptions: for example the belief that the cosmos necessarily has a beginning and an end looks rather odd in an inter-cultural perspective, for Buddhists, for example, deny that the cosmos has a beginning or an end.

The point of doing the Poincaré recurrence theorem, and the Liouville's theorem in the above generality is now clear. Having brought in cosmological considerations, the natural thing to ask is whether the theorems would remain valid if Newtonian theory were to be replaced by some other theory. The general forms of the above theorems assures us that the conclusion of recurrence will continue to hold even if Newtonian physics is wrong (as we know it to be). Though there is nothing much by way of a relativistic statistical theory, or even a relativistic account of matter, the above theorems will apply also, using the geodesic hypothesis, to geodesic flow on a manifold. Indeed, the theorems, in the above form will continue to hold so long as physical time evolution is instantaneous and deterministic.

Even the requirement of deterministic evolution is not binding, and can be substituted by stochastic evolution. A Markov chain evolves stochastically, but instantaneously, the state at time t depends only on the state at time t–1, and not on earlier states. The state space of a finite Markov chain is divided into recurrence classes, where the states keep repeating, and a stationary Markov chain stays within a recurrence class. Under fairly general conditions, a the transition probabilities of a general Markov chain would tend to become stationary and the chain would tend to settle down in a particular recurrence class.

Quantum mechanics introduces another dimension: to be precise, while time evolution in quantum mechanics corresponds to a stationary process,[8] the state space of a quantum-mechanical system is infinite-dimensional—it is a separable Hilbert space according to von Neumann's axioms for quantum mechanics—so that the above theorem does not directly apply to a quantum-mechanical gas in a box. While there are versions of the Poincaré recurrence theorem for quantum-mechanical systems, it is not our objective here to examine these.

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[8] C. K. Raju, *Int. J. Theor. Phys.* **20** (1980) 680–97

Indeed, it is most certainly *not* our objective to try to prove that recurrence must occur under all conceivable physical circumstances. Rather, the object was to point out that recurrence is refutable but not trivially refuted: that the notion of *âtman* presupposes a certain view of time (quasi-cyclic time) and the world (a quasi-recurrent cosmos) which view is (a) physical, for it is refutable (i.e. one can conceive of physical circumstances under which the belief is false), though (b) it is *not* trivially refuted by current physical theory, according to which recurrence must occur under a wide variety of circumstances. Currently, however, we cannot say whether these circumstances, in fact (or with large probability) prevail.

How the soul turned metaphysical

A key point of confusion here is this: *âtman* naturally translates to soul, but everyone knows that the soul is a prime example of metaphysics. So how do we reconcile this understanding with the above assertions that relate *âtman* to physics?

To understand this we need to understand the history of the concept of the soul in Western thought. Such a history does not seem to have ever been written. Because it inevitably involves the history of the church, and political changes in church ideology, it brings into play very powerful vested interests. Hence, it is hard for even prominent Westerners to write this history honestly—look at what happened to the history of the church written by Isaac Newton, which has remained suppressed[9] for 250 years, though there now seems a possibility that some of it may see the light of the day.

Briefly, the notions of soul in early Christianity were very similar to the beliefs in *karma* and *samskâra*. Quite possibly this similarity was due to the extensive trade between India and the Roman empire via Alexandria, involving some 120 ships annually, a trade which according to Pliny drained the surpluses of the Roman empire at an alarming rate. To this interaction we must add the tremendous intellectual clout of Alexandria in the Roman empire, before the Great Library was burnt down by rampaging Christian mobs.

At any rate, the view that prevailed in early Christianity was that of Origen of Alexandria. Contrary to Indian tradition, where belief in *karma-samskâra* has been used to promote the injustice and inequity of the caste system, Origen proclaimed something

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[9] For more details, see C. K. Raju, "Newton's Secret", ch. 4 in *The Eleven Pictures of Time: The Physics, Philosophy and Politics of Time Beliefs*, Sage 2003. A recent discussion may be found on the Historia Matematica discussion list, on my assertion of the "cartload" of Newton's unpublished papers, with D. T. Whiteside, a Newton scholar from Cambridge, who turned abusive since he could not deny it.

very closely analogous to the *karma-samskâra* doctrine as proof of God's belief in equity and justice:[10] equity because God created all people equal, and justice because different people were rewarded and punished with different *samskâra*'s according to their karma in the preceding life.

Jerome (who translated the Bible into Latin) initially hailed Origen as immortal genius, and called him the greatest teacher of the church after the apostles. Subsequently Jerome turned around, and joined Augustine and Justinian both of whom condemned Origen. The root cause of the condemnation was the Neoplatonic belief in equity.[11] After state combined with church, this belief in equity became unacceptable to the church. The Roman church came to regard the Neoplatonists as its worst enemies, and engaged in a long list of atrocities against them, eventually shutting down all philosophical schools in the Roman empire in the mid 6th c. CE. At about the same time Origen's point of view was condemned by Justinian (ca. 540 CE)and the Fifth Ecumenical Council (552 CE)

In this process Christian theology was transformed. The key to this transformation was provided by Augustine. Origen had visualised a cosmos where all souls were created blameless, and all eventually returned to their initial perfection. Augustine, to the contrary, visualised a world which was a brief testing ground for souls. At the end of the test God would pronounce a judgment, and send some souls to heaven and others to hell *for eternity*. In Origen's view, hell was a temporary reform school, and heaven an advanced academy for training souls, before their next birth in this world. In Augustine's view, heaven and hell were the final resting places for the soul.

This transformed theology transformed the notion of time from quasi-cyclic time to apocalyptic time—a view in which time has a beginning, and progresses rapidly to the Day of Judgment, followed by an eventual fork towards heaven or hell.

There were many other interesting features of this transformed notion of time. But, the key thing that immediately concerns us is the following. Origen's view of the soul involved life after death in a physical context, for it involved a series of lives in a series of cosmic cycles. But in Augustine's view, *reincarnation* was replaced by *resurrection*: life after death exact once. The only reasons for believing in life after death were now moral. Thus, the key consequence of Augustine's view was that it plucked the notion

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[10] Origen, *De Principiis*, Book II, chap. 9. Frederick Crombie, trans., *The Writings of Origen*, vol. X in *Ante Nicene Christian Library,* ed. Alexander Roberts and James Donaldson, T&T Clark, Edinburgh, 1895, p. 136.

[11] For more details, see C. K. Raju, "The Curse on 'Cyclic' Time", ch. 2 in *The Eleven Pictures of Time*, cited earlier.

of soul from its original physical context:and put it in a purely moral and metaphysical context. Augustine's view of the cosmos was tailored to suit his moral requirement of a simplistic division between good and bad. Subsequently, Origen was cursed and Augustine was accepted in Western Christianity; and the subsequent colonial expansion spread this view far and wide.

The temporal dichotomy

This history of the notion of the soul helps us to understand how the notion of the soul evolved from a refutable physical notion into an irrefutable metaphysical notion. It helps us to understand the difficulty that Hegel had with the very possibility of a non-metaphysical ethic. This transition of the soul from a physical to a metaphysical entity was accompanied by various other side effects.

Though Augustine's aim was to set up a simple moral dichotomy between good and bad, in the process, his arguments against Origen had another consequence. Augustine misrepresented the views of Origen he wanted to refute: to this end he portrayed quasi-cyclic time as no different from super-cyclic time. In common, if somewhat meaningless, terminology, he did not distinguish between different types of recurrence, and portrayed any kind of recurrence as identical to exact and eternal recurrence. While such misrepresentations of opponents are commonly used by theologians, Augustine's misrepresentation had a particularly unfortunate consequence. It created a belief in a temporal dichotomy—a belief that there are exactly two pictures of time: linear and cyclic.

The mistaken belief in this temporal dichotomy has deeply infected Western thought down the ages. Nietzsche's entire philosophy and value system, founded on eternal recurrence,[12] derives mistakenly from this dichotomy. Mircea Eliade[13] continues to describe Indian thought using the phraseology of the "myth of the eternal return".

Worse, the dichotomy has penetrated physics, right from the days of Newtonian mechanics. Newton's mentor, Isaac Barrow opined that time was like a line, either

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[12] M. Heidegger, "The Unity of Will to Power, Eternal Recurrence, and Revaluation", ch. 4 in *Nietzsche*, vol. 1: *The Will to Power as Art*, and also "the Doctrine of Eternal Recurrence as the Fundamental Thought of Nietzsche's Metaphysics", ch. 1 in *Nietzsche* vol. 2: *The Eternal Recurrence of the Same*, trans. D. F. Krell, San Francisco, HarperCollins, 1991. It should be noted, however, that while Nietzsche was thinking in *physical* terms, Heidegger transforms this to metaphysics, thereby making the proposed value system more secure against changes in physical theory.

[13] Mircea Eliade, *Cosmos and History: The Myth of the Eternal Return*, trans. W. Trask, Harper and Row, New York, 1959.

straight or circular. Newton chose "linear" time for no clear-cut reason. In current physics, Hawking does much the same thing in his chronology condition, which uses essentially Augustine's arguments to exclude closed time-like curves from spacetime. The same problem persists in the currently accepted resolution of the grandfather paradox of time travel. This penetration of theology into the structure of "hard" physics makes it so much harder to decide the physical validity or invalidity of quasi-recurrence.

There is an even harder problem, because the use of this temporal dichotomy has led to the confusion between mundane time and the superlinear time of physics, since both are classified as linear time, hence treated as if they were identical. This has led people to overlook that criteria like refutability in the philosophy of science use the belief in mundane time, which directly conflicts with the belief in superlinear time used in the formulation of physics. Thus the demarcation of physics from metaphysics uses hypothesis about time that are in direct conflict with the hypothesis about time used in formulating the equations of current physics.[14] The absurdity of the situation passes unnoticed because of the illusion created by the Augustinian dichotomy.

Resolving the dichotomy: the tilt in the arrow of time

Disentangling this knotty situation requires a reformulation of physics, along the lines attempted by me. This involves a reformulation of relativity theory, using functional differential equations or a tilt in the arrow of time. With this reformulation, there remain no valid logical, physical, philosophical objections to closed time loops or quasi-recurrence on any scale: microphysical, mesophysical, macrophysical, or cosmological.[15] However, even with this reformulations, the factual prevalence or otherwise of quasi-recurrence remains an open question. A tilt is, at best, a local necessary condition for the prevalence of quasi-recurrence: if the cosmos is quasi-recurrent, we can locally expect a tilt in the arrow of time, but a tilt by itself does not guarantee that the cosmos will be recurrent—for that the tilt would have to increase with time.

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[14] C. K. Raju, "Mundane Time", ch. 8 in *Time: Towards a Consistent Theory*, cited earlier.

[15] Stephen Hawking (personal communication of 16 Dec 97) now concedes the possibility of closed time loops at the microphysical level, "Space and Time Warps by S. W. Hawking as at 18/10/95".

Indian objections: Lokayata

The above line of thought meets various known objections, in Western thought, to the notions of *âtman* and *moksa*. It does not, however, address the objections raised against these notions in Indian tradition. Thus, though the Upanishadic notion of *âtman* comes at the beginning of recorded Indian tradition, it was neither the universal nor the "predominant" belief in Indian tradition.

From the earliest recorded Indian tradition, Lokâyata rejected quasi-recurrence and the notion of *âtman*. They opined that rituals related to life after death aimed to extract *daksina*, by fooling people through hopes of a future life.[16] There is undeniably a certain force to the Lokayata criticism, for nowhere in Indian tradition do we find an account of *âtman* related to an attempt to arrive at a physical understanding of the cosmos as was done above: Brahmins who believed in *âtman* did so purely on the strength of Vedic authority. And there is no denying the fact that such beliefs contributed (and continue to contribute) greatly towards their livelihood.

The Lokayata argued for the validity of their criticism on the grounds that belief in *âtman* did not satisfy the test of *pratyaksa*, the only reliable method of validation that the Lokayata accepted. (This was in direct contrast to the rejection of the empirical as contingent, and the acceptance of logical deduction or inference as the sole method of proof in present-day mathematics.[17])

Incidentally, it is little known but interesting that Pâyâsi actually performed[18] numerous experiments with dying persons, including macabre experiments with condemned felons, to test empirically the existence of *âtman*. Needless to say, Payasi's experiments all had a null result: what they conclusively refuted was the naive notion of life after death.

Indian objections: Buddhist

From a contemporary viewpoint, however, the most satisfactory and comprehensive analysis/synthesis is that of the Buddha. The Buddhist view[19] is also more moderate:

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[16] D. P. Chattopadhyaya and M. K. Gangopadhyaya, *Carvaka/Lokayata: an Anthology of Source Materials, and Some Recent Studies*, ICPR, New Delhi, 1990.

[17] C. K. Raju, "Computers, Mathematics Education, and the Alternative Epistemology of the Calculus in the Yuktibhasa", *Philosophy East and West*, **51**(3), 325–62.

[18] Debiprasad Chattopadhyaya and Gangopadhyaya, *Carvaka/Lokayata*, cited above, pp 8–13.

for the Buddha goes neither to the one extreme of rejecting all that is not manifest, nor to the other extreme of uncritically accepting on authority what is manifestly not credible.

(a) **The continually changing self:** The Buddha tackled the deeper question of persistence of identity under change. In the scenario of a quasi-recurrent cosmos, two successive cycles of the cosmos are not *exactly* the same—such an assertion would be meaningless, for if there is identity there can be no succession. Thus, to speak meaningfully of *âtman*, there must be some difference between a person and his life in this cycle, compared to the same person and his life in the preceding/next cycle. Given that there is a difference, in what sense, then, are the two persons the same? In what sense can we speak of this difference being "small"?

A similar problem ("recognition problem) arises in present-day technology, for example, in the development of speech-recognition software, which is conventionally required to understand as "same" two words articulated "slightly" differently. Such software is commercially widely available, as of date, and has even been bundled along with new operating system releases. This enables one to assess how far present-day technology can formalise and mimic widespread but intuitive human notions of "sameness with a difference". The same problem arises in digital recognition of handwriting, since two signatures may be "really" the "same" even though they are manifestly different: in what sense is that difference small?

The Buddha adopted a different notion of self which makes quasi-recurrence irrelevant. He noticed, first of all, that this difficulty with identity and difference is not specific to the context of quasi-recurrence—the same problem arises also from instant to instant. Between each instant and the preceding/next instant there must be some difference. (We can apply again the same argument about identity and succession—if the two instants are identical, there can be no succession between them.) The existence of an underlying unchanging sameness is neither manifest nor does it seem valid to infer it from the differences that *are* manifest. The "sameness" between two things that are manifestly different is ultimately a matter of convention. Thus, on the Buddhist view, *âtman* in the sense of an unchanging essential "self" does not persist even unto the next instant. Though the change is manifest we continue to speak of the same person only due to a paucity of names.

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[19] C. K. Raju, "Time in Medieval India". In: *Science, Philosophy, and Culture: Multidisciplinary Explorations*, Part 2 (D. P. Chattopadhyaya and Ravinder Kumar eds), PHISPC, New Delhi (1997) 253–78. Also in: *History of Indian Science, Technology, and Culture, AD 1000–1800*, ed. A. Rahman, PHISPC/Oxford Univ. Press, 1998, New Delhi. Reprinted with independent copyediting mistakes in *Indian Horizons*, **46**(4) (1999) and **47**(1) (2000) 40–71.

(b) **History dependence and the existence of the past:** The Buddhist view of a "self" that changes each instant has often been called the Buddhist doctrine of flux, or momentariness. Though literally correct, such a view is not quite accurate, for, today, it usually tends to incorporate the further implicit assumption that only the present exists. I am not aware that such a further assumption is part of the Buddha's philosophy. The Buddhist notion of *paticca samuppâda*, which I have interpreted as incorporating history-dependent causation,[20] differs from 'instantaneity' (or the belief that future and past are decided by the present, as in Newtonian physics, or in Einstein's misunderstanding of relativity theory). In Indian tradition, this belief that the future and the past are inherent in the present instant is found in the Sankhya-Yoga tradition, according to which a Yogi, by concentrating on the world at this instant, can know its future and past. Though the Buddhist view accepts the Sankhya-Yoga idea of discrete time and the atomic instant,[21] it leads to a different ontology, where one cannot assert, like Aristotle, that anything past has ceased to exist. Since this ontology asserts the continued existence of some part of the past, it obviously cannot be the same as McTaggart's A series view.[22] This ontology is nevertheless not the same as McTaggart's B-series, either, for it is a key element of the Buddhist *dhamma* and notion of self, the very idea of *nirvâna*, that some aspects of the past may yet cease to exist! The failure of McTaggart's dichotomy with history dependence should be borne in mind, considering the importance of McTaggart's paradox for the 20th c. CE Western philosophy of time.

As I have indicated earlier,[23] McTaggart's paradox echoes the arguments of Sriharsa in his *Khandanakhandakhadya*. Sriharsa, an Advait Vedantist, was clearly influenced, like Sankara, by Buddhist views. But, by his time, there were not many Buddhists left in India to respond to him, so there is no known Buddhist response to him. Therefore, in terms of Indian tradition, the above argument against McTaggart's paradox can also be regarded as the Buddhist response to Sriharsa's arguments, which properly attack the ontology of Nyaya.

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[20] In my understanding, history-dependent causation corresponds to a mathematical model of evolution governed by functional differential equations with retarded deviating arguments, while instantaneity corresponds to an ordinary or partial differential equation model of evolution, with no deviation in the arguments. In this context, a tilt corresponds to functional differential equations with both retarded and advanced deviating arguments. See, C. K. Raju, "Electromagnetic Time", chp. 5b in *Time: Towards a Consistent Theory*, Kluwer Academic, Dordrecht, 1994.

[21] For further details, see C. K. Raju, "Time in Indian and Western Traditions", cited earlier in note 4 above.

[22] J. M. E. McTaggart, [1908], "The Unreality of Time", reproduced as "Time", in R. M. Gale ed., *The Philosophy of Time*, MacMillan, London, 1968, pp 86–97.

[23] C. K. Raju, "Philosophical Time", ch. 1 in *Time: Towards a Consistent Theory*, cited earlier.

The persistence of this ontology of instantaneity, from Aristotle to Einstein, and indeed to the present day, is an indication of how deep seated it is in Western culture. I should add that a similar notion of instantaneity and action by contact (*samyoga*) through the underlying aether (=sky=*akasa*) is found also in the thinking of the Nyaya school. In the case of *karma* and *samskâra*, the intermediary is named *adrsta*. On Buddhist thinking this *adrsta*, as the name suggests, is not manifest; neither can its existence be validly inferred. Since the manifest (pratyaksa) and inference (anumâna) are the only two proofs admitted by Buddhism, we must abandon this notion of adrsta according to Buddhism. On current physical theory, if we abandon this idea of action by contact intermediated by e.g. the field concept of current physics,[24] we are left with the model of history dependence.

The Buddhist ontology of history dependence can perhaps be better understood in analogy with the African belief in life after death. When a person dies, that person has manifestly ceased to exist, and is no more *pratyaksa*. Nevertheless, memories of the person survive, in the minds of those who were close to him, these memories may be the mundane causes of present-day actions (such as instituting a benevolent fund), and these memories allow us to infer the continued existence of the person. For, what is the cause of those memories? It would seem a natural view that that person, surely, is part of that cause, and making that person non-existent would, then, also make the cause non-existent! Thus, on the African belief, the person does not cease to exist immediately upon death, but slowly fades out of existence as those who knew him die out, and he passes into the memory of the community. That is, the person, though in a sense past, has not quite ceased to exist. This continued "ghostly existence" of the past is fairly well captured in the colloquial Hindi term for both ghost and past which is *bhuta*!

(c) **Self, Cause and Social Organization:** The Buddhist notion of self, and the accompanying notion of history dependent causation has numerous social consequences. To take a simple example, on the Buddhist view of cause, the seed is not the cause of the plant, because if it were, the seed would produce the plant in the granary itself. But in the granary the seed does nothing except to produce, at the next instant, a seed very much like it, and we continue to speak of it as the same seed only to economise on words, because of the paucity of names. It is only when this seed is implanted in the ground, and the ground is watered, and the seed becomes bloated up, and manifestly a different seed, does it become capable of producing a plant. Further, it is solely a matter of convention by which we identify the seed as the "main" cause and the earth and water etc. as "subsidiary" causes.

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[24] C. K. Raju, "The Electromagnetic Field", ch. 5a in *Time: Towards a Consistent Theory*, cited earlier.

I will not go very deep into this issue here, but it is immediately obvious how the above argument applies to the situation of patriarchy, and the current social system where people take their surname after their father. Patriarchy is premised on the idea that the seed, supplied by the male, is the "main" cause of the offspring.

There are other social contexts in which the above argument is relevant. For example, Bill Gates is the richest man today just because he is regarded as the "main" cause for Microsoft Windows, and is accordingly regarded as fit to be rewarded with a lion's share of the royalty each time we install Microsoft Windows on a computer. (Of course, Bill Gates did not invent the idea of a GUI, but that is how the legal system decides the inherence of causes.) A social system which permits such disproportionate concentration of resources is also a social system in which others necessarily have to be disproportionately poor. Those interested in exploring such further consequences of alternative notions of cause may refer to my book on *The Eleven Pictures of Time*, cited earlier.

(d) **Self, Logic, and Closed Timelike Curves:** A final point regarding the notion of self, as it changes with notions of time. Consider the well-known case of the quantum mechanical Schrödinger's cat which is both alive and dead at a single instant of time, after it is attacked by the dangerous chemical MICE (Methyl Iso-CyanatE). The situation is NOT as if the cat is either alive or dead, and we don't *know* which is the case, but the situation is that we know that the cat is BOTH alive and dead at a single instant of time. That is, the cat is ontically rather than epistemically half-dead+half-alive.

This seems terribly unreasonable—a contradiction, in fact—and reason (2-valued logic) assures us that contradictory premises result in complete nonsense, since any conclusion whatsoever may be drawn from contradictory premises.

Nevertheless, Buddhist logic, which I have interpreted as quasi truth-functional logic, perfectly well permits such a possibility. In the Brahmajala Sutta,[25] the Buddha himself speaks of the possibility a world which is both finite and infinite, since it was then accepted as possible that contradictory qualities may inhere in one entity. It is not so easy to escape from this possibility even as of today. Consider the statement "this pot is both red and black". One can try to escape the contradiction by saying that "this part of the pot is red, and that part is black". However, moving towards logically atomic statements may also push one into the physically atomic domain.

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[25]The Brahmajala Sutta of the Digha Nikaya of the Sutta Pitaka, trans. T. W. Rhys Davids, *The Dialogues of the Buddha*, or the more readily trans. Maurice Walshe, *The Long Discourses of the Buddha*, Wisdom Publications, Boston, 1995, pp 78–79.

I have linked logic, in both Buddhism and quantum mechanics,[26] to the notion of time. In Buddhism, the connection is provided by what I have called the instant-as-cosmos analogy. In this analogy, which inverts the more usual Samkhya-Yoga analogy of the cosmos-as-instant, the instant itself is endowed with a structure, somewhat like a miniature cosmos. (Thus, a string of instants becomes similar to a string of cosmic cycles, within each of which the instantaneous self is born and dies.) Since the instant is not a structure-less point, extending causal relations across the diastema between two instants is as problematic as extending causal relations across the billions of years in a cosmic cycle. Since there is no notion of before and after within the instant, the different "parts" of the atomic instant are all simultaneous, and co-existent. Logically, this corresponds to modelling the instantaneous state of the world by a quasi truth-functional logic.

A similar thing is used in my structured-time interpretation of quantum mechanics. A quick and easy way to see the connection between time and logic in present-day science is to think of time travel using TWISTs—traversible wormholes in spacetime. Such TWISTs can be used to set up a time machine as in Carl Sagan's novel *Contact*, based on Kip Thorne's non-fictional proposals.[27] Consider a situation in which Kip Thorne extends his hand through his wormhole time machine and shakes hands with his younger self. We have here a situation of two Kip Thorne-s of different ages being present at a single instant of time (else how do they shake hands?). It requires only a slight stretch of the imagination, to see how this can be converted into a situation where one is alive and the other dead.

A closely parallel situation already arises in physics that has been known for over half a century. In quantum field theory, or particle physics, it is a common enough physical situation to see a photon create a pair of particle, which recombine to produce back another photon. The created pair consists of a particle and an anti-particle, for example an electron and a positron. (I emphasize that these are perfectly "real" particles, and one can, for example, see and photograph their tracks as a very common event in a bubble chamber.) Using CPT or the Stueckelberg-Feynman interpretation of an antiparticle as a particle travelling back in time, one can perfectly well regard this as a closed loop in time executed by a single particle, the electron. What has changed is only the notion of self or identity. To exclude the paradoxes created for 2-valued logic by closed loops in time, we may prefer to think of two particles, where there is actually one. (Of course, if this single particle is in two different places at the same time, we will actually "see" two

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[26] C. K. Raju, "Quantum-Mechanical Time", ch. 6b in *Time: Towards a Consistent Theory*, cited earlier.

[27] For a popular account, see Kip S. Thorne, *Black Holes and Time Warps: Einstein's Outrageous Legacy*, W. W. Norton & Co., New York, 1994.

different particles, but apart from charge conjugation and parity reversal, corresponding to reversed time evolution, they will have the same properties.) This forces us to assert pair creation: in quantum field theory that particles can only be created in pairs.

Thus, notions of history-dependent causation and "instantaneous" (rather than momentary) self-hood, together with the accompanying notion of quasi truth-functional logic can also elegantly handle problems concerning "self" in current scientific situations where Schrödinger's cat is simultaneously both alive and dead or in macrophysical situations where Kip Thorne extends his hand through his wormhole (TWIST) time machine to shake hands with his younger self.

The profound impact on society and ethics of the closely related Buddhist notions of self and time is too well known to be reiterated here. Perhaps the strongest argument in favour of these notions is that they could not ultimately be overcome by their opponents in any way except through appeals to authority, and, ultimately, by resorting to direct violence, though no sensible system teaches a violent victory as the test of the truth.