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# On The Matter of Time

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**Abstract**

Drawing on several disciplinary areas, this paper considers diverse cultural concepts of time, space and materiality. It explores historical shifts in ideas about time, observing that these have gone full circle, from visions in which time and space were conflated, through increasingly divergent linear understandings of the relationship between them, to their reunion in contemporary notions of space-time.

Making use of long-term ethnographic research[1] and explorations of the topic of *Time* at Durham University's Institute of Advanced Study (2012-13),[2] the paper considers Aboriginal Australian ideas about relationality and the movement of matter through space and time. It asks why these earliest explanations of the cosmos, though couched in a wholly different idiom, seem to have more in common with the theories proposed by contemporary physicists than with the ideas that dominated the period between the Holocene and the Anthropocene. The analysis suggests that such unexpected resonance between these oldest and newest ideas about time and space may spring from the fact that they share an intense observational focus on material events. Comparing these vastly different but intriguingly compatible worldviews meets interdisciplinary aims in providing a fresh perspective on both of them.

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[1] Since first visiting Cape York in 1982, and conducting my Doctoral research there in the early 1990s, I have conducted ethnographic research with Aboriginal people in the area, working primarily with the Kunjen, Kokobera and Yir Yoront language groups in Kowanyama, and occasionally with other groups along the Mitchell River. I have written extensively about their ideas, beliefs and practices. I have also worked with several indigenous groups in south-east Queensland. I have these communities' permission to use the material gathered through this collaborative work – indeed the knowledge was shared with a remit from the elders to 'tell people about Aboriginal culture'. Some key publications arising from this work that are relevant to this paper include: Strang 1997, 2001, 2002, 2009a. 2009b. Other ethnographic work is listed at https://www.dur.ac.uk/ias/staff/?id=10491

[2] Durham University's Institute of Advanced Study has an annual research theme, and this paper owes much to my discussions with its 2012-13 *Time* Fellows and other colleagues in Durham. In this sense it is an outcome of these conversations, and this is reflected in the number of 'pers. comm.' citations. All of the Fellows have published other work on *Time*, and details about them and their work are available at https://www.dur.ac.uk/ias/fellows/1213/

## Introduction

Dominant representations of time tend to depict an 'arrow of time'[3] or a flow carrying chronological events forward and leaving a wake of history. Philosophers have usefully presented alternate models (Deleuze and Guattari 2004, Bergson 2004), and anthropologists have described many diverse cultural and sub-cultural ways of understanding, representing and experiencing time (Gosden 1994, 2003, Fabian 1983). This paper considers some of the key transitions that have occurred in these conceptual models. But its primary focus is the materiality of time: what most contemporary societies imagine and represent as a linear progression is increasingly being understood as a multi-dimensional movement of matter through time and space (Dautcourt and Abdel-Megied 2006, Velev 2012). To explore this topic, and test the imaginative potential of both cross-cultural and cross-disciplinary comparison, the paper compares two wildly unrelated explanations about the materiality of time: the explanatory theories of modern physics,[4] and the metaphysical concepts of Aboriginal groups in Australia who lived as hunter-gatherers for many millennia prior to European settlement, and who retain many aspects of their customary lifeways.[5]

Though these 'first and last' models could not be more different, they share an intense focus on the movement of matter through conflated space-time. In this respect, the notions of space, time and relationality that characterise the cosmological explanations of pre-literate hunter-gatherers resonate remarkably well with contemporary concepts describing space-time continua. That is not to suggest that hunter-gatherer societies understood spatio-temporal multi-dimensionality in Einsteinian terms: clearly they did not. But their efforts to conceptualise time, space and materiality do challenge some of the assumptions implicit in notions of progress and 'civilisation' – that hunter-gatherer societies had limited abilities to compose sophisticated and coherent cosmological constructs. This makes an important political and historical point: that modern science does not have a monopoly on comprehensive – and comprehensible – explanations of the physical world.

As writers on the medieval cosmos have shown (eg. Dinkova-Bruun *et al* 2013), while earlier societies did not have the technologies of knowledge available to modern scientists, they often had extraordinary capacities, in culturally diverse idioms, to understand and describe

[3] The notion of forward directional time appears in a range of disciplinary areas, surfacing famously in the poetry of medieval scholar Omar Khayyám's *Rubáiyát,* 'The moving finger writes, and, having writ, moves on…' ( Fitzgerald 2010:12). A more contemporary view from physics on 'time's arrow' was articulated by astronomer Thomas Eddington (1928) and in a recent essay by George Ellis (2008).

[4] The material presented comes from multiple conversations with contemporary physicists, and literature that they recommended. This by no means represents a balance with the Aboriginal Australian ethnography, but there is not room for both, and I am assuming that most readers of this journal will be more familiar with concepts of time in physics than they will be with indigenous Australian worldviews. However, a deeper ethnographic perspective on physics and physicists would be a welcome complement to this paper.

[5] Although this analysis is drawn from specific ethnographic examples, the concepts expressed are broadly shared by other Aboriginal groups in Australia. Similarly, the major concepts underpinning indigenous Australian's concepts of time and space – for example notions of generative 'nature' beings and the dominance of seasonal cycles – seem to recur (with distinct local variations) in the cosmologies of many other hunter-gatherer societies.

the phenomena they observed. Hunter-gatherers' lives depend upon maintaining a highly detailed lexicon of knowledge about all potential resources: what they are, where they are, and when they are going to be available. Unlike societies with highly specialised economic practices, those dependent on such holistic knowledge necessarily read all of the component details of their material environments with an unusual degree of intensity (see Benterrak, Muecke, and Roe 1996).

Contemporary physics is equally concerned with the close observation of material events. Its emic perspective is framed in precise geometric terms and produces theories that are intended to be testable and able to predict material changes. Observations are carefully measured – indeed measurement is methodologically central, providing a generic language suitable for cross-cultural exchange.[6] In contrast, the cosmological explanations of hunter-gatherers are couched idiomatically in metaphors and images, stories and songs that – while they have some meta-discursive accessibility – are only fully comprehensible within a specific cultural context or via the translatory meta-discourses of anthropology.

From an etic perspective, however, there are some intriguing commonalities, and I am curious about why this might be the case. The hypothesis that I would like to propose is that this is due to their shared, intense and immediate focus on the observation of material processes. This common focus may explain not just how, but also *why* Aboriginal cosmological concepts resonate, in particular, with those in contemporary physics. This kind of close reading of the material environment seems to have been marginalised by the new artefacts and ways of comprehending time and space that emerged in many societies between the Holocene and the Anthropocene.

**Telling Time**

It is useful to consider some key transitions in the most dominant ways of telling time, with a caveat (and I feel I should underline this at least three times) that such a large overview inevitably subsumes vast historical and cultural diversities. The rationale for focusing on the broader pattern is that it illuminates two things. First, that along with the emergence of dualistic notions of nature and culture, there was a concomitant separation of social time (as experienced phenomenologically) and technological time (as measured by time-telling artefacts). One might also point to a related divergence between art and science.

Second, it could be said that an increasing physical separation of humankind from the non-human encouraged a shift away from temporal regimes based on highly intensive observation of the material world. Societies focused more on disembedded artificial

[6] Linguistic theories concerned with the historical emergence of more literal forms of explanation (Downes 2014, Lakoff and Johnston 1980) cohere with those examining movements towards more standardised forms in visual representations, such as maps, in which a common metric – a standard 'key' of symbols – has emerged (see Harvey 1980, Strang 1997). Such forms still require some explanation, but have become widespread (or one might say globalised). A similar process has affected the communication and use of international scientific discourses and language about 'The Laws of Physics'.

technologies for measuring time, before returning, with the advent of modern scientific theories, to close deconstructive examination of material processes and their spatio-temporal behaviours. This raises a question about scientific narratives that describe a progressive chronological journey towards scientific Enlightenment suggesting, instead, that understandings of the world circle or spiral through multiple ways of knowing. This resonates with cosmologists' contemporary picture of a Universe busy with different spatio-temporal systems that, whatever their cosmic scale, are cyclical in nature, though perhaps (simultaneously) moving together within 'a stream of increasing entropy' towards some sort of grand finale (Martin Ward pers.comm.).

On a more literally down-to-Earth scale, notions of interrelated cyclical systems characterise both the earliest and most recent cosmological explanations. Cross-culturally, all concepts of time generally contain both linear and cyclical elements, but they differ radically in the extent to which these are dominant.[7] If we go back (or possibly forwards) to the beginnings of human thought, we find hunter-gather societies with primarily cyclical concepts of time. In an Aboriginal cosmos, these are framed by a spatio-temporal vision of an 'earlier' creative era, commonly known as the Dreamtime,[8] but the linearity is minimal: there is no sense of a 'distant past' or even a 'past' as such: the 'early days' of the Dreamtime are described as being maybe just a few generations ago. The ancestral era remains 'present' and active, generating all of the seasonally recurring material movements. Time-telling is based on detailed observations of these material events and their interrelationships.

*Fig. 1. Alma Wason, Kunjen elder, on the Mitchell River, Cape York (photo by the author).*

[7] Implicitly, all cosmological explanations need to deal with tensions between notions of (infinite) cyclical movement and (potentially finite) underlying linearity. As Tom McLeish observes (pers. comm.), these were classically articulated in the debate between Lucretius and Theophrastus, in which Lucretius suggests that the world's finite history is demonstrated in the erosion of mountains: 'Do we not see rocks roll down, torn from high mountains, unable to endure the mighty force of a finite timespan? For they would not suddenly be torn away and fall if they had from infinite time past suffered without damage all the harsh treatment of ages.' (Lucretius, *De Rerum Natura* v313-317 in Sedley 1998: 176).

[8] In Cape York this creative era is more often translated as the 'Story Time' and sometimes 'early days', but the term 'Dreamtime' is more widely used and understood across Australia and now internationally.

My research with Kunjen and other Aboriginal language groups in northern Queensland records ways of time-telling focused on highly localised environmental cues, such as 'when the crocodiles lay their eggs'; 'when blossoms appear on the ti-trees' and 'when the floodwater reaches its peak'; 'when the fish are fat'; 'when storm birds come to nest' (Paddy Yam, Alma Wason and Lefty Yam, in Strang fieldnotes 1992-3).[9] Celestial constellations also have a local material and cultural frame:[10] thus another informant described one as 'the Emu' (John Clarke), and noted other totemic beings that populate the night skies. Such indicators recur in other ethnographies across Australia, as Memmott notes:

> The importance of natural time orders in traditional Aboriginal life is stressed throughout the ethnographic evidence for the whole continent. These orders consist of solar rhythms and associated diurnal/nocturnal cycles, seasonal cycles, changes in climate, flora, fauna and other environmental conditions (e.g. quantities of surface water); also lunar rhythms and associated tidal movement and animal behaviour. (2013: 1)

Memmott also records terms for prevailing winds at certain times of the year; precise variations in rainfall; fruits ripening; times when oysters are in season, etc. He cites Howard Morphy's point, that 'Aboriginal people have a capacity to measure one event by another and to take one thing as a sign for another' (1999: 265). Such measurement is largely qualitative: although there are generic concepts, Aboriginal worldviews (beyond counting to three or four) tend to define things and events as being specific and unique[11] (Rudder 1983), with a strong emphasis on their relationality.[12] This is illustrated in my own fieldwork:

> When they see that [tree] flowering too, you know that snakes mating with one another… and later they lay eggs, same time as crocodile. (Alma Wason, Strang, fieldnotes 1992*)*

Critically, this also applies to concepts of space and time: neither is quantified, only seen in relation to other places or events. Howard Morphy notes that 'seasonal cycles… are seen to be intimately involved with the action of ancestral beings – for example, the lightning snakes, who bring about the wet season and cause the flood waters to rise' (1999: 267).

Prior to the disruption of colonisation, the vast lexicon of knowledge held by such communities was transmitted via immensely detailed ancestral stories and songs describing the landscapes and events generated by ancestral activities. These offered not only a

[9] I have used people's full (English) names here to indicate that they are ethnographic research participants.
[10] Clearly the celestial maps used in Western societies are also rooted in a specific historical and cultural past.
[11] A useful illustration is provided by my experience of working with a mixed stock team near Kowanyama. When 60-70 workhorses were mustered from a large paddock, the non-Aboriginal stockmen would count them into the yard, while the Aboriginal stockmen would account for each horse by name and/or physical description, and could say if any particular animals were missing (Strang, fieldnotes 1989).
[12] While this is not synonymous with scientific notions of relativity, it shares with these a central concept that material processes depend upon/are formed by the interactions and interrelations between things.

comprehensive account of the material environment, but also a blueprint for managing people and resources in relation to a cultural landscape[13] seen as a sentient and agentive partner in events. Thus, 'telling time' was conceived of as a mutual enterprise, co-constituted by human and non-human beings and things, with no conceptual bifurcation between culture and nature. This lack of ontological distinction between the human and non-human is common to many hunter-gatherer epistemologies, and is generally coherent with a human-environmental relationship closely embedded in local material events (see Descola and Palsson 1996, Ingold 2000).

**Keeping Time**

Societies shifted away from this intense focus on the material environment as they developed different modes of engaging with the world. Such changes were undoubtedly incremental: reliance upon material observation also characterised early agricultural ways of telling time, and early almanacs point to multiple environmental indicators used to plan planting, harvesting etc. Thus Hesiod's *Work and Days,* written ca. 700 BCE, describes both localised and celestial indicators:

> ll. 383-404) When the Pleiades, daughters of Atlas, are rising (10), begin your harvest, and your ploughing when they are going to set (11). Forty nights and days they are hidden and appear again as the year moves round, when first you sharpen your sickle…
>
> (ll. 448-457) Mark when you hear the voice of the crane (17) who cries year by year from the clouds above, for she give the signal for ploughing and shows the season of rainy winter; but she vexes the heart of the man who has no oxen…
>
> (ll. 564-570) When Zeus has finished sixty wintry days after the solstice, then the star Arcturus (25) leaves the holy stream of Ocean and first rises brilliant at dusk. After him the shrilly wailing daughter of Pandion, the swallow, appears to men when spring is just beginning. Before she comes, prune the vines, for it is best so. (Evelyn-White 1914).

As agriculture became a dominant economic mode, however, the comprehensive knowledge about local resources and their material relations essential to hunter-gatherer economies became less critical. Time-telling became more reliant on celestial movements and the broad seasonal changes in temperature and rainfall required for farming.[14] Although a focus on seasonal cycles remained, calendrical development shifted the emphasis to lunar and solar equinoxes etc. This required more precise quantitative

[13] In anthropology and archaeology, a cultural landscape is formed dynamically by a society or group's specific engagement with its material environment over time. Thus Bender describes a 'palimpsest' of cultural ideas and values being inscribed on the landscape through material practices (Bender 1993, see also Strang 1997).

[14] Marshack interpreted some Neolithic carvings as a seasonal calendar (1972), though this is contested (Dibon-Smith 2012).

methods, and Hannah notes the 'denaturizing of time through technology' demonstrated in efforts to capture celestial events in the architecture of early Greek temples (2013).

While formalising seasonally-oriented astronomical calendars, agricultural societies also produced artefacts for measured time-reckoning. Water clocks may have been used as early as 4000 BCE in China and India, but there is more certain evidence of their use in Babylon and Egypt ca.1600 BCE. Sundials, candles or incense sticks and hour glasses were also used, but water clocks remained the most abiding and accurate artefacts for time-telling prior to industrialisation.

*Fig. 2. The Tower of the Winds below the Acropolis in Athens contains a time-telling* clepsydra *(water thief) (photo by author).*

Did the historical development of sophisticated artefacts for time reckoning encourage a conceptual divergence between notions of time and space? By providing ways of measuring time that were increasingly (and literally) 'artificial' in their form, this new material culture – and the social technology of measurement itself – enabled societies to tell time without using environmental cues. Environmentally oriented methods didn't disappear,[15] but they became less important as time-telling moved away from reliance on non-human species and things as temporal indicators. Nor were the agentive powers of the environment forgotten: celestial movements were seen as the outcome of the activities of pantheons of gods, but the humanisation of these deities (differing fundamentally from the non-human totemic

[15] For example Hannah notes a return to celestially oriented water clocks in the Hellenistic period (pers. comm).

beings of hunter-gatherer societies) suggests in Durkheimian terms[16] a stronger sense of human agency in the production of time, which time-telling artefacts could only reinforce.[17]

In medieval Europe, building on ideas initiated in the East, religious scholars composed lunar calendars punctuated by festivals, and rural societies entered regimes in which church bells marked time into measured parcels for work and worship. It is worth noting that the word 'clock' comes from the Celtic terms *clagan* and *clocca,* meaning 'bell'. The 1300s brought a florescence of elaborate clocks in town centres, often on Abbey churches, signalling the changes between secular and sacred hours of the day (Van Rossum 1996).

*Fig. 3. Church bells, Verona (photo by author).*

The precise measurement of time and a complementary development, the spread of literacy and the production of material records, encouraged the construction of linear historical narratives and served to fix events sequentially (see Goody 1977).[18] Each 'cyclical' day or season became embedded in a sequential calendrical record of days, weeks and years. Simultaneously, population growth and greater mobility in agricultural societies demanded rapprochement between competing calendars and forms of time keeping, as well as spurring hegemonic expansion. Thus linear notions of time made their way around the world, often subsuming the localised and more spatially and cyclically focused temporal regimes of indigenous communities. In Australia and across the Pacific such communities found themselves forced to conform to the horticultural economic practices introduced by missionaries, and to their Christian notions of time.

With industrialisation, artefacts for time-telling grew increasingly accurate, parsing time into ever smaller units attached not to celestial objects, but to earth-bound activities. The

[16] Durkheim (1968) famously argued that human societies compose their deities to reflect their own social and political arrangements. As I have noted elsewhere, a shift from worshipping 'nature beings' to worshipping humanised deities implies an important change in relations between the human and non-human (Strang 2014).

[17] There are some potential links here with Harold Innis' ideas about the effects of communications media and how these 'bias' societies' emphases on time or space (2008). Also relevant is Hart's exploration of the effect of new media on Aboriginal Australian worldviews (1993).

[18] Goody argued that literacy also encouraged greater use of mathematics, scientific and secular thinking (1977). Finnegan and Horton, while suggesting that how texts were used was more important than the literacy itself, agreed that literacy enabled major shifts in modes of thought (Finnegan and Horton 1973, Finnegan 1988).

invention of pendulum clocks in 17th century Europe came with the carefully measured work patterns of factories and production lines. As with earlier time-telling artefacts, these hourly and daily time measurements became pinned to linear records of events. Gaining from more sophisticated methods of navigation, global temporal unification was eventually achieved. Other forms of travel aided this process: for example the development of the railways in Britain erased remaining minor local variations in time, famously requiring the sacrifice of a seven minute difference between London and Bristol time (based on local sundials), and establishing the primacy of Greenwich Mean Time. Multiple time markers – on-the-hour radio pips; the bells and whistles of factory shifts; the alarm clock – became omnipresent, displacing the need to consider the rise and fall of daylight and other environmental cues.

With varying rates of adoption, many societies therefore became intensely dependent on time-telling material artefacts and on temporal narratives and other knowledges presenting time in linear form. Material culture, such as artificial lights, urban housing and industrial forms of production, further shielded people from immediate engagement with environmental processes (Freeberg 2013). Individually, watches became prosthetic extensions of the body (Gell 1998), further replacing *kairos* (social time) with externally constructed *chronos* (Crang 2013). In this way, human-made material and intellectual technologies provided at least an illusory capacity to 'tame the flow of natural time' (Ben-Dov 2013).

**Experiencing Time**

There are inevitable recursive relationships between technological developments, phenomenological experience, and ideas about time. Temporal perceptions can undergo massive compression and expansion, and this capacity is emphasised by time-telling artefacts and by particular discursive and visual representations. As Prosser observes, actors experience time viridically, in accord with specific representational and material contexts (2013). The tick-tock of time can seem painfully slow under conditions of boredom or misery: fast under the pressure of a deadline; inexorable with a focus on impending mortality.[19]

[19] The latter is beautifully expressed by John Taylor's famous chronophages, in which the 'grasshopper' (a technical term for the mechanical device upon which a non-pendulum clock relies) canters along, eating every second.

*Fig. 4. John Taylor's 'Midsummer Chronophrage' in the National Museum of Scotland (photo by author).*

Phenomenological experiences of time are closely linked with well-being. Levine compares variations in the pace or tempo of life in different cities and considers how these mesh with cultural ideas about quality of life (2013). Theorists such as Virilio (2006) observe how reliance on time-telling artefacts and related social practices can promote a sense of acceleration. Harvey talks about space-time compression (1989); and Manjikian notes the capacity of discourses about 'crisis' and 'emergency' to present highly condensed visions of time in which 'urgent' actions are justified (2013).

Cyclical ideas about time persist on an everyday basis (Zerubavel 1985, 1999), and *chronos* is readily subverted: persons and memories of persons, images, artefacts laden with history, texts and landscapes: all bring the past and sometimes the future into the present (Graziosi 2013). Biographical narratives provide 'a form of afterlife' enabling the intersubjective engagement of the living with the dead and their historical context (Ní Dhúill 2013). Revolutions have an ideological function, as Epps says, 'to change time', attempting to resuscitate a perceptually better past, or to accelerate events to meet a utopian vision of the future (2013).

But acknowledging the complexity and elasticity of social ideas about temporality doesn't alter the reality that, in most large-scale societies, time has come to be perceived in primarily linear form, if not as a unified human history, as more or less parallel societal and individual chronological progressions, mediated by largely artificial methods of time-telling. A linear vision of time permits infinite expansion: just as 'history' established an idea of a chronological narrative of human progress through time, ideas about 'evolution' provided

an extended vision of prehistory and evolutionary time, in which non-human species marched into – and often out of – the frame, and humankind (or at least some of it) supposedly 'progressed' towards civilisation.

The concepts of time underpinning dominant epistemologies therefore imply a widening disconnect between people and their immediate material environments. There is a sense that reliance upon artificial and primarily linear time-telling, and a plethora of other sophisticated technologies, preclude more 'emplaced' ways of being, replacing the rich *topos* of place with the empty container of *chora* (space) (Crang 2013).

This returns us to the issue of materiality and the matter of time. The shift away from time-telling based on detailed observation of material events in the surrounding environment has been accompanied by a reframing of the material world, not as a sentient partner in events, but in Cartesian terms, as an array of physical objects. There is a fundamental difference between being an integral part of an animate, sentient material landscape, and merely traversing or acting upon one composed of physical things.

In thinking about time, this disconnect has a critical effect on ideas about things and persons coming into and going out of being. As anthropologists such as Strathern (1996), Verdery and Humphrey (2004) and others have observed, there are multiple cultural diversities in concepts of personhood and consciousness, and the extent to which these are considered to be located in a physical body over time and space. This is equally true historically: societies have proposed a plethora of ways in which things and persons might precede coming into being and continue beyond mortality.

In industrial societies, however, these ideas have become detached from scientific understandings, devolving to art and religion the responsibility to elucidate the non-tangible dimensions of life. This is not how science began: when Greek philosophers were laying the foundations for scientific modes of thought, middle and late Platonism still imagined celestial points providing access to eternal dimensions of being (Hannah 2013). But critically, over time, ideas about other dimensions or 'eternal worlds' have moved further and further away, out of local environments. At first, they didn't go very far, being conceived of as if on a high mountain peak, such as Olympus, or as an interior underworld of dark rivers crossing to other domains. Valhalla is described as if merely a nearby – albeit superhuman – feasting hall. But later notions of Heaven imply a distanced, more abstract location.

This suggests that scale is critically important: linear temporalities, being eschatological in nature, favour long-term visions of the movement of persons and things through time towards a far distant end. As eternal worlds or other dimensions became larger and more distant they seem to have been simultaneously dislocated – literally abstracted – from the immediate material environment. Such an enlargement of spatial and temporal views, by promoting more linear visions, makes it more difficult to reconcile notions of time and

space.[20] And perhaps this is why it is only with a return to an intense focus on the material environment, and on materiality itself, that these have been conceptually reunited.

**On the Matter of the Person and Other Things**

Scientists have struggled to agree on ways to describe the movement of matter in integrated notions of space and time.[21] Conventional physics employs a mathematical model locating material events in a coordinated system of one temporal and three spatial dimensions. In such a system, longitude, latitude and height determine a location, and time defines both the *where* and *when* of an event. An alternative coordinate system, at a subatomic or supergalactic level, may demonstrate a relatively different temporality. De Mello Koch notes the confirmation of general relativity provided by experiments showing that atomic clocks aboard space shuttles slow down relative to synchronized clocks on Earth. But, like other string theorists, he suggests that there may be 10 or even 26 dimensions of space, and perhaps multiple temporal dimensions, depending upon the form of the matter (particles, strings and membranes offering different potentials), and upon the gravitational fields and media through which they move. Thus 'spacetime is not fundamental: it is an emergent concept', and debates continue as to how many dimensions of space and time are required to describe the Universe (pers. comm. 2013).

What does appear to unite the various areas of contemporary physics, quantum field theory and so forth is that these ideas have been generated by an intense scientific focus on material processes and the movement of matter. Time is not a force but a geometry in which matter moves according to its mass, energy and electromagnetic charge across the curved forms of space-time. The Universe is thus composed of movements of matter[22] in both time and space and, theoretically, this pertains at all micro and macrocosmic levels. Space-time cannot exist without matter. Macdonald notes Einstein's 'hole argument' that,

> On the basis of the general theory of relativity … space as opposed to 'what fills space'… has no separate existence… There is no such thing as an empty space, i.e., a space without [a gravitational] field. … Spacetime does not claim existence on its own, but only as a structural quality of the field. (Einstein, 1952: 155)

There is an interesting relationship between these ideas and notions of 'becoming' (Deleuze and Guattari 2004), which may be said to have deeper historical roots in concepts of incarnation. There is a growing consensus across the natural and social sciences that we inhabit a Universe in flux, a sea of potentiality in which not just things but also persons and

[20] This suggests, further, that there is a need to keep a weather eye on the links between large-scale visions of a *longue durée,* as promoted by Guldi and Armitage (2014), and the material and ideational contexts that shape notions of time and space.

[21] Schopenhauer made early efforts to consider ways to combine time and space (1813); Poe commented that 'space and duration are one' (1848), and Wells necessarily tussled with these ideas in order to conceive of a time machine (1895).

[22] I note that 'matter' is used in various ways in physics, but given that this is a very loose comparison of concepts, the presence or non-presence of mass may not be critical here.

ideas act upon and shape each other (Tsing 2004), and all matter is characterised by 'vitality' (Bennett 2009). This draws attention to the dynamic relationship between material and non-material things. Debates concerned with mind and brain are usefully illustrative (see Clarke 2010, Morphy and Morphy 2014). While we cannot compose thoughts without the neurological pathways and electrons that carry them (or indeed without the physical support systems on which these rely), thoughts and utterances are not material, and what may be said to be 'mind' is not located merely within the brain, but emerges from a dialectical engagement with a material and social environment. Ideas might be as ephemeral as a shimmer of light or, manifested through action, they might outlive the temporary corporeality of our physical selves.

Thus there are both social and physical processes of materialisation and dematerialisation in multiple spatio-temporal dimensions of being. Matter cycles through states of order and disorder. Persons, ideas and things not only act upon each other, they also coalesce, dissolve and perhaps reappear in other forms, times and spaces. Only the movement of matter is constant.

> Death means change of form… You are not the same person you were a minute ago. A part of you is already dead and a part is being born. (Sri Swami Satchidananda)

Ideas also have their own gravitational fields: for example holy places such as Mecca attract a density of thoughts and persons simultaneously, which is beautifully expressed in the ritual anticlockwise circumambulation of the *Tawãf.*

> Circumambulating around Allah, you will soon forget yourself… You have been transformed into a particle that is gradually melting and disappearing. (Ali Shariati 2012)

An understanding of matter as particles is useful, presenting them as fundamental to the composition of all – organic and inorganic – things. The recognition of common material ingredients challenges conventional distinctions between physical and biological categories and between the human and non-human (Coole and Frost 2010). One might also say that it challenges distinctions between the tangible and intangible. Such fluid notions of materiality are nicely demonstrated if we return to a historically earlier (but who knows, maybe later) spatio-temporal location, and consider how the movement of matter is conceptualised in the metaphysics of Aboriginal Ancestral 'Law'.[23]

**Hydrotheological space time**

There are two major movements in the canons of Aboriginal Law that are relevant here. The first is a creation story about how the world was made. With minor local variations, this is

[23] 'The Law' is a term commonly used by Aboriginal Australians to describe the whole body of cultural knowledge on which their lives are founded.

broadly as follows. Totemic ancestral beings, primarily in animal or elemental form but exhibiting human qualities, emerged from within the land. Through their actions as hunter-gatherers, they formed the landscape: pushing up hills to hold back floods; sticking spears into the ground that became trees; opening string bags to release flying foxes into the world.

*Fig. 5. Serpent beings in early rock art, Mungana Caves, Cape York, Australia (photo by author).*

A key figure in Aboriginal Australian origin stories[24] is the Rainbow Serpent, which is both composed of and manifests the generative power of water. Informants in Kowanyama often refer to it simply as 'the Rainbow', articulating a belief that these are one and the same thing. Everything in the world emerges from this central hydrotheological being. When the ancestral totems completed their creative journeys, they 'sat down' back into the land and waterscape, to be reunited with the Rainbow. This continues to generate life in an animated and sentient landscape, and its power is concentrated particularly in the water places that form the majority of sacred sites.

If we distil the essence of this story, it presents the things that comprise the material world rising up (one might say like steam), forming out of the invisible ancestral domain in which power and also potential chaos reside. This notion of the material world continually coalescing or 'becoming' is central to many origin myths, whether we consider Maori stories of how the water god, Tangaroa, formed the world out of the chaos of *Te Kore* (Strang and Busse 2009), or Yoruba ideas about a world composed of water, and the creative force Olódùmarè's role in breathing persons 'into being' (Idowu 1982).

Also central to many versions of genesis is a vision of persons and things emerging from invisible (and typically fluid) dimensions of disorder to 'be manifested' as orderly and visible material beings. This is readily evident in Australian Aboriginal terms for such manifestations or incarnations, which translate specifically as 'becoming visible' or 'becoming material' (Morton 1987). This is simultaneously about 'awakening' to consciousness: thus, in Munn's

[24] With hundreds of different language groups across Australia, there are many origin stories, and other important figures, but the Rainbow Serpent is one of the most recurrent and powerful of these.

ethnography of the Warlpiri, the Dreamtime, *Tjukurrpa*, is opposed to *Yitjara,* which means 'the time of awakeness' (1973: 23-24).

Ontologically, then, human consciousness is presented as being concurrent with material being, though it is more difficult to define whether this is seen as an epiphenomenon of materiality (as in scientific ideas about thoughts arising from electromagnetic charges and neurons within the brain), or as material being forming out of emergent consciousness (as in some religious explanations). Possibly it is both, representing a shift from the 'potential' consciousness of the ancestral forces to the 'realised' consciousness of the human lifespan. In considering 'the matter of the mind', Howard and Frances Morphy raise a key question as to whether notions of mind work as a meta-category that crosses cultural boundaries. Their research shows that Yolngu language (in NE Arnhem Land) situates thought and knowledge within the human skull, but also links it to the ancestral knowledge that flows from within the landscape (Morphy and Morphy 2014).[25]

Aboriginal ideas about 'becoming' recur in a second key cycle of material movement: the human lifetime. As Kunjen elder Lefty Yam put it, in Kowanyama: 'we all come from the Rainbow' (Strang 2002: 1). The Rainbow is a cyclical process carrying matter and energy between the invisible world within the landscape and the visible world above it. Underlining water's generative power, human spirit beings are believed to 'jump up' from water sources to enliven the foetus in a woman's body. Thus every person has a 'home place' in the waters of their clan's estate, and the terms for such places underline a conceptual shift between non-material and material dimensions of being. In Kunjen, therefore, this site is called *erk elampungk,* which translates as 'place-eye-home' or 'the home place of your image'.

Similarly, in Yolgnu, *mel, mangutji* translates as both 'eye' and 'well/permanent source of freshwater'. Also relevant is the term *liya gapu-mirr/* which, by including *gapu-mirr* (water-having), describes an infant whose fontanelle is still open and pulsing, and linked with the ancestral knowledge believed to be held in the waters of a sacred site (Frances Morphy 2014).

[25] There are useful potential avenues to explore here with ideas about distributed agency and cognition (Knappett and Malafouris 2008, Clarke 2010)

*Fig. 6. Fishing for 'yabbies' (freshwater crayfish) at Maggie's Well, an important Kunjen site in Cape York (photo by author).*

The purpose of human lives, according to Aboriginal Law, is to relive the lives of the ancestors. This can be envisaged as an arc of movement following the form of the upper (visible) semi-circle of the rainbow. Emerging from ancestral waters, new persons are close to them, as illustrated by kin-terms describing a child as 'little grandmother' or 'little grandfather' (Strang, fieldnotes 1992) but, as implied above, they are still somewhat unformed (or perhaps un-informed). Their life journey then follows an ancestral pattern: secret sacred knowledge is conferred through initiation at various stages, and through this progressive composition people return towards their origins and 'become closer to the ancestors' (Alma Wason 1992).

When they die, their spirit must be sung back ritually to its 'home', so that it can be reunited with its totemic being and dissolved back into the Rainbow, into the residual ancestral potentiality held in the land. The major creation stories of Aboriginal Law, and those describing the reproduction of humans, non-humans and things, therefore demonstrate a keen appreciation of the cyclical nature of material processes. The Rainbow Serpent is, in effect, a hydrotheological cycle, generating people and things on epochal, seasonal and human scales, and carrying them, as if through the membrane of the surface of the land, between intangible and tangible worlds.

Critically, this is a spatio-temporal process. In describing the Dreamtime, or Story Time, people do not say 'when', they say 'where'. As Howard Morphy notes: 'place has precedence over time in Aboriginal ontogeny. Time was created through the transformation of ancestral beings into place' (1999: 256). The ancestral domain, rather than being 'somewhere else' is thus an omnipresent alternate dimension from which things and persons emerge, coalescing only temporarily in material and conscious form, before returning to a state of potential being. This potentiality, and the non-linearity of the process, is expressed in a belief that these appearances will recur, as expressed in the kin terms describing grandchildren as 'little grandmother', 'little grandfather' etc.

Above all – or rather below/within all – this process is seen as being empowered not by human agency, but by that of sentient ancestral forces contained in the material environment and concentrated particularly at sacred sites. Human agency has a supportive role, to assist generative processes through increase rituals: performances designed to stimulate the reproduction of each site's particular totemic species or things. Kunjen elders in Cape York therefore describe 'Catfish Dreaming' sites at which the scattering of bark from particular trees will increase the supply of catfish in nearby waterways, and rain-making places where rituals using leaves from particular trees will bring rains (Strang, 1997).[26]

[26] Memmott notes an Alyawarr example from the Central Desert where certain clans have responsibility for the 'Dark Dreaming' rituals which serve to shorten or lengthen the duration of night (2003: 6).

The belief that ancestral power remains constant in both place and time conflates past and present, presenting a cosmological vision of continual life-generation (Morphy 1999). This circularity is reflected in the narrative form of ancestral stories, which rarely contain linear sequences, only interconnected events which readily loop backwards and forwards in both space and time. In this sense the pre-modern may be said to be post-modern in style (Strang 1994, 2001). Like the material cues through which space and time are read, narrative events are coherent only in relative terms. It is therefore a considerable challenge to translate them into the chronological narratives more familiar to non-Aboriginal audiences.[27]

**South American Temporalities**

A brief comparison suggests that conflated concepts of space-time recur in hunter-gatherer societies. Indigenous South Americans would readily recognise the precepts of Australian Aboriginal space-time and their intensive ways of 'reading the country'. For example, the Yámama in Tierra del Fuego relate origin myths in which 'the ancient one who changes not' embarked upon a major creative endeavour (Moore 2013: 2 citing Gusinde 1961). They describe daily solar movements from 'when the light is spread around' to 'the crossing over of darkness', and seasonal cycles of time based on material cues, such as:

> 'The time when the bark is loose' is in early Spring when sap runs in beech trees and the bark can be removed to make canoes, a season also associated with the call of the snipe. (Ibid.)

In Peru, *Kay Pacha* refers to a concept of space-time in which *pacha* simultaneously denotes 'a moment or interval in time and a locus or extension in space' and does so, moreover, at any scale (Salomon 1991, cited in Moore 2013: 3, see also Dransart 2006). Qollahuaya-Andean notions of hydrological and spiritual circulation through their sacred mountains (*allyu*) conceptualise the movement of matter in terms of hydrotheological flows in which material and spiritual being is carried between invisible and visible dimensions of existence (Bastien 1985).

The cosmos of the Kogi in northern Colombia is composed of nine layered worlds representing 'vast and nested cycles of time encircling all levels' (Moore. Ibid. see also Reichel-Dolmatoff 1976, 1990). The Kogi *mamas* (priests) are the only ones able to escape this cyclical temporality via ritual practices, and it is worth noting the capacity of many cultural rituals (both secular and religious) to provide precisely this atemporality or 'un-timeliness'. They do so by opening access to other, intangible worlds via entry to sacred places, or by inducing visionary trance states through music, dance, drugs, fasting, prayer etc. (Stanner 1963). An Australian comparison is provided by an important Aboriginal ritual in Cape York, which entails initiation into secret sacred knowledge. Known as 'passing

[27] I have transcribed a number of Aboriginal stories for the groups in Kowanyama, to assist them in their efforts to regain the land and resources appropriated by settlers (Strang 1994, 2001). However, I am aware that the imposition of a linear narrative form has its own recursive effects.

through the rainbow', this involves both immersion in and regurgitation from the water sources that connect the material world and the ancestral domain (Strang 2002).[28]

The belief that empowering esoteric knowledge can be gained by entering other worlds underlines the idea that a person's 'becoming' is constituted partly by the acquisition of reflexive consciousness, as well as drawing attention to the corollary, that the end of this conscious span entails a loss of being and memory. Aboriginal Australians see reunification with one's totemic 'mate' as a form of dissolution back into the pool of ancestral power – a loss of form or 'unbecoming'. In the issue of mind and material being, the losing of the material self is therefore accompanied by the loss of accumulated knowledge. Frances Morphy (pers.comm.) describes how, in the Yolngu language, the term *buku,* 'forehead', stands for 'intent'/will' or 'intentionally acquired knowledge', while the term *buku-y moma* describes 'forgetting' or 'leaving knowledge behind at death'. This can be linked with a term for losing form, *buku but-marama,* which translates as 'forehead fly away-cause', and connects with mortuary rituals that return the dematerialised human spirit to its original pool of dynamic potential being and becoming.

There is striking resonance with Reichel-Dolmatoff's work in South America. In Kogi notions of 'forgetting', the mature soul returns to a state of innocence and perfection from which it can be reborn (*ishkuéldyi*). Having reached a stage of *seiváke* called *nakuíza*, meaning 'he who forgot', the person must make an intentional effort to forget everything they have learned during their life, in order to return to a childlike state. A *seiváke* state also involves *sui séishi*, 'to feel cold', which entails mastering all emotions such as passion, lust, sorrow, and anger. Thus, devoid of all sensory experience, the person loses his or her individuality (Reichel-Dolmatoff 1976, 1990).

Such worldviews therefore encapsulate ideas about the dissolution of the literally embodied person and the memories and thoughts it contains. This brings to mind classical visions of the waters of Lethe and the process of forgetting, or of the sea as the 'great sink'[29] into which selfhood and memory dissolve. This loss of being is beautifully captured in Byron's *Childe Harold*:

> Roll on, though deep and dark blue ocean – roll!
> Ten thousand fleets sweep over thee in vain;
> Man marks the earth with ruin – his control
> Stops with the shore.
> He sinks into thy depths with bubbling groan,

[28] As Tom McLeish points out, rainbows are ineluctably elusive, disappearing as one approaches them (pers.comm.), but what this ritual usefully highlights is an overriding idea: that in an Aboriginal cosmology, power – the Rainbow – is contained or 'held' in the land, and most specifically in water. There is a strong link with the concept of 'home' or 'home place' which similarly 'holds' the spirit.

[29] Sinking into the watery depths of the sea recurs as an image of death and dissolution in many visual and literary arts, representing the end of the 'river of life' or 'life-time' (see Strang 2004). A classic example is Poe's poem, *The Doomed City* (1831).

Without a grave, unknell'd, uncoffin'd and unknown.
(George Gordon Byron (Lord Byron) *Childe Harold,* ca. 1812: clxxix)

Also linking hunter-gatherer cosmological ideas is the belief that, in dissolution, the person returns to a common pool of potentiality that is more than human. Like Aboriginal temporal regimes, South American cosmologies contain a clear sense of partnership with an agentive, generative material environment. In this worldview, human, non-human species and things are mutually constitutive, and the movement of matter in time and space is a collective process of becoming in which events, things, species and persons recur or 'reincarnate' cyclically, in multiple spatio-temporal locations.

**Stringing it together**

There are useful conceptual similarities between these cyclical loops of material events and the spatio-temporal possibilities of contemporary general relativity, in which matter or objects moving through time and space can literally catch up with themselves (Gödel 1949, see also Dautcourt and Abdel-Megied 2006). The ways in which hunter-gather regimes describe multiple movements in and out of material coalescence also resonate with modern physicists' descriptions of the capacities of matter to move through space and time in various forms according to its encounters with specific gravitational fields. Thus, at the microcosmic end of the sub-atomic particle scale, quantum field theory considers how open and closed strings corresponding to all matter curl through space-time in multi-dimensional couplings and decouplings (De Mello Koch 2013).

While still contested, such theories build on more conventional empirical analyses of matter in flux: the movements of atoms and their component protons and electrons; shifting strands of DNA; and cruder cellular processes of division, subdivision, growth and decay. On a larger empirical scale, people and things flow around the world. Ideas flow too, thoughts composed of electromagnetic charges crackle across neurons, and are transmitted through speech, images and texts, zigzagging between people, across airwaves, and between Earth and space via satellite. Humans, other species and things inhabit emic spatio-temporal *umveldts,* co-existing in a flux of conjunction and disjunction (Crang 2013, Tsing 2004). They leave material traces: cultural landscapes and artefacts record the coming and going of people and ideas; seas and atmospheres absorb their detritus; and geological deposits reveal eons of environmental change – the loess of time (Zhou 2013).[30]

This comparison of 'first and last' models therefore highlights a shared emphasis on cyclical movements within conflated notions of time and space. Both, it would appear, are strongly influenced by intensive observation of relational material events: on the one hand a necessary close reading of all aspects of a specific local environment; on the other, a systematic exploration of the micro and macro material interactions composing the physical

[30] 'Loess' is dust, the detritus of geological processes of change over time.

universe. Comparing the metaphysical ideas of hunter-gatherers with those of contemporary physics therefore illuminates both forms of cosmological explanation. Though still – perhaps ineluctably – dependent upon metaphors, the academy strives to provide a 'plain style' language through which it is possible to compare scientific discourses *and* the thinking that underpins Aboriginal worldviews (Downes 2014). Meanwhile, hunter-gatherers' own comprehensive and powerful narratives about 'becoming' assist us in bringing multiple theories together to conceptualise more coherently the spatio-temporal movements of energy and matter.

The comparison also encourages a more sympathetic vision of human-non-human relations and the agentive capacities of non-human species and things. The deconstruction of the world into its most infinitesimal parts, and an appreciation of how these travel dynamically, potentially rekindles – on a much larger scale than that of hunter-gatherer societies – a bioethic of respect for and sense of partnership with the things and species coinciding with humankind's becoming. In multiverses composed of swirling particles it is impossible to ignore the puny ephemerality of the momentary coalescence of stardust of which the human body is composed. And even if a person is, as some would have it, merely a coalescence of matter animated by electromagnetic and chemical interactions, the understanding that we are immutably composed of the same stuff as everything else is a powerfully connective idea, recombining nature and culture, and resituating human beings within a universal flow of matter through space and time.

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