When words and worldviews decay: thoughts on the art–science nexus, on how a poem can be as beautiful as a scientific theory

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ΑΣΤΕΡΩΝ ΠΑΝΤΩΝ Ο ΚΑΛΛΙΣΤΟΣ (Sappho)[1]

1. Introduction

The Plump trio—comprised of sculptor Marc Rogerson, together with sound artists Philip Samartzis and Dave Brown—is a Melbourne-based group whose latest project operates at the isthmus between the arts and the sciences. On April 24 2008 this Australian trio, augmented by video artist Marcia Jane, presented a fine-art installation titled "Cluster" at the Victoria College of the Arts Margaret Lawrence Gallery.[2] In this exhibit, translucent illuminated fiberglass pods were juxtaposed with fields of both sound art and video projection (see Fig. 1, together with Section 2). Feedback sensors allowed the sculptures, sound and light to react to the presence of any observers in the space. Jointly supported by both the City of Melbourne and the Australian Institute of Physics, this exciting conceptual exhibit served both as an artistic metaphor for the quantum mechanical realm[3], and a means of strengthening a nascent bridge between the fine-art and physics communities.

The remainder of this report is broken into three sections. Section 2 briefly documents some key features of Plump's "Cluster" installation. Two related readings of this installation are then given, one from the perspective of a physicist (DMP, see Section 3), and one from the perspective of a sculptor–painter (MR, see Section 4). It is hoped that this report will serve to contribute to a core theme of the

[1] D.A. Campbell (ed.), *Greek Lyric: Sappho and Alcaeus*, Harvard University Press, Cambridge Massachusetts, 1982.
[2] Website for installation at www.clusterbyplump.blogspot.com.
[3] To keep this contribution self contained, Section 3 seeks to give an accessible outline of the salient concepts of quantum physics, needed for a reading of this chapter.

present volume, that of challenging the traditional divide between the arts and the sciences, by exploring some of the points of nexus between them.

2. Description of Plump's "Cluster" installation

The visitor to the gallery enters a darkened space—four walls, floor and ceiling. Within this space are clusters behind clusters of Marc Rogerson's large floating fiberglass sculptures (see Figs. 1 and 2). Pod-like, illuminated, amorphous, catching fan-generated air currents. The pods are animated and illuminated by a hidden interactive logic, brought about by electronic motion detectors, relays, electric fans and motion sensitive lights. This rich visual field is drenched in an exquisite auditory field, with eight speakers surrounding the exhibition (one of which can be seen to the left of the presenter in Fig. 1), from which Philip Samartzis' composition pulses and emanates. Two further speakers lie inside the pods, from which radiate the sounds of Dave Brown's composition, as triggered by the observer via the motion detectors. The combined effect is that the visitor is partly a co-creator in the experience of visiting the exhibition, their presence serving to substantially change the composition of light, movement and form. To be close to the suspended pods invites a tactile, visceral urge to push in amongst them, which many did, thereby creating a most direct way of interacting. Even to stand totally still in itself is rewarding as according to the exigencies of human traffic flow, the room may empty, leaving the visitor in total darkness and silence, but with a sense that the installation is alert and upon the slightest motion will react accordingly or in kind, with all of its sonic and visual sensibility.

3. Edited transcript of introductory talk, by David Paganin

What follows is an edited transcript of DMP's talk at the opening night of Cluster by Plump, which was intended both to introduce the gathered artists and physicists to the installation, and to explore possible points of resonance between these communities.

3.1 Introduction

Hello and welcome. Marc Rogerson, sculptor for this installation, gave me the brief to "Express the shared nature of art and science in the most beautiful part of both their manifestations". This I now do, as a preface to the exquisite installation of illuminated sculpture and sound art in which you are immersed.

Figure 1. Opening night of Cluster by Plump, showing clusters of illuminated suspended pods. Image courtesy of Michael Blamey.

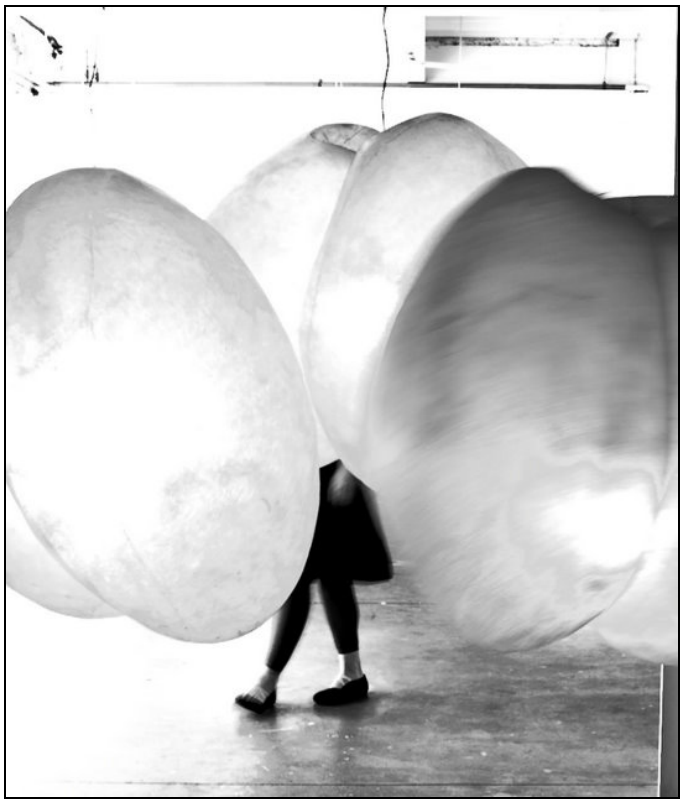

Figure 2. Several illuminated pods in motion. Image courtesy of Michael Blamey.

3.2 Three plus one: the creators of "Cluster"

This installation was created by four members of an artistic trio known as "Plump". Marc Rogerson, the sculptor, sculpts the quanta of matter, the atoms. And let me point out that the word "quanta", which is the plural for "quantum" (as in "quantum physics") refers to something very simple. It simply refers to pieces, to discrete lumps, to packets, to bits. So, when we speak of "quanta of matter", we mean the individual pieces or building blocks of matter, namely the atoms. So, Marc Rogerson, the sculptor, is responsible for the quanta of matter. Philip Samartzis and Dave Brown, the sound artists, sculpt the quanta of sound ... this is quantum mechanics after all, and in quantum physics the quanta, the lumps of sound, are known as phonons. Marcia Jane, who augments the trio, is a video artist, and she sculpts the quanta of the light field, known as photons.

3.3 On beauty as a nexus point between art and science

The account I give tonight is personal. My opinion. I am not telling you that "this is the way it should be", I am not telling you that "this is the way it is", rather I am telling you that "this is the way I feel" about certain interfaces, certain parallels, certain kinships between the arts and sciences, about the "shared nature of art and science". Let's give this "shared nature" a name, let's call it the "art–science nexus".

And with regard to this art–science nexus: beauty, the creation and appreciation of beauty, for me, is very much a point of nexus between the arts and the sciences. This I want to explore now. I want to explore this nexus point via a question: "In what sense can a poem be as beautiful as a physical theory?".

Let's begin with a poem. Choose Sappho, the great ancient Greek poet. She wrote a gorgeous line, which I'll translated into English as: "Of all the stars, you are the most beautiful". Even in English translation, this is a stunningly beautiful verse, an evocative, brilliant line of genius poetry. Now, you appreciate this beautiful line of poetry, you appreciate this beautiful verse when you hear it in English, but trust me when I say that you would appreciate it all the more deeply if you were to spend several years studying ancient Greek. You want to more deeply appreciate Sappho? Then knuckle down and learn the language of Sappho.

In what sense can a poem be as beautiful as a physical theory? We've just mentioned a poem, so let's now mention a physical theory. For now, I want to concentrate not on quantum physics, but on classical physics, namely the brand of physics that is in at least reasonable accord with our everyday common sense. The classical physics of the light that fills this room—let's call it the "electromagnetic disturbance" that fills the room—classically speaking, this electromagnetic disturbance is considered to be governed by a certain set of physical laws, differential equations known as the Maxwell equations. These are the equations of classical ("common sense") physics, which govern the evolution in space and time, the ebb and the flow, of the light field, the electromagnetic field in this room. And these equations, these Maxwell equations, are stunningly beautiful. I am not going to justify this last statement. I am just saying, that as far as I am concerned, these equations are stunningly beautiful. Many physicists would agree with me. But again, in order to deeply appreciate the statement I have just made, regarding the sublime beauty of the Maxwell equations, one would need to spend several years studying mathematical physics, the language of nature.

You want to understand Sappho? Study the language of Sappho. You want to understand and appreciate more deeply the beauty of the Maxwell equations? Study the language of nature: mathematical physics.

Now, I'm a fan of both Sappho and Maxwell. Both are stunningly beautiful.

And I don't mean that they are beautiful in a cold, distant, merely intellectual way—nothing wrong with being intellectual, nothing culpable in having a few brain cells stretched, as it were, with either the finer points of ancient Greek grammar or with a particularly challenging piece of mathematical physics—rather, I am talking about how both Sappho's poems and Maxwell's equations are beautiful in a visceral way[4], that hits you in the stomach, that sends a trill/frisson/shock through the blood, that excites a quiet spasm of emotional thrill—this is what I speak of, this is what I want to focus on, this is what I want to feel, this is what I want you to feel, when I speak of the beauty of both Maxwell's equations and Sappho's poems.

As another point of nexus between the arts and the sciences, I would argue, again for me personally, that the urge to create and appreciate something beautiful, either alone or in collaboration with others,

[4] This statement was intended to resonate with Marc Rogerson's intention for the audience to have a "visceral response" to his sculpture, and to the Plump trio as a whole (Marc Rogerson, private communication, February 2008).

is what I aspire to as a scientist, as a physicist. The urge to create something beautiful, this is "research", in the strong sense of the term, when one is researching physical ideas, physical ideas that no-one has seen or appreciated before, to create something new, to create something beautiful. This is the urge to *create* something beautiful. The urge to *appreciate* something beautiful in the physics realm—such appreciation is about learning, learning about the researches of others—learning from books, learning from papers, learning in person from dialogue with other physicists. Again, the urge to create and appreciate something beautiful, either alone or in collaboration with others, is what I aspire to as a physicist.

The urge to create or appreciate beauty is also what I aspire to as an artist. Now, I'm an amateur artist, very much an amateur ... I enjoy composing and performing music, I enjoy creative writing, I enjoy painting. The urge to create and appreciate the beautiful is what I aspire to as a scientist ... the urge to create and appreciate the beautiful is also what I aspire to as an amateur artist.

Again, again, again: beauty as a point of nexus between the arts and the sciences. Be it a poem by Sappho or Gwen Harwood, a mathematical theorem of Euclid or Emmy Noether, a painting by Russell Drysdale or Jackson Pollock, a physical theory of Albert Einstein or Stephen Hawking, a musical piece by Peter Sculthorpe or Olivier Messiaen, a scientific discovery by Marie Curie or Edwin Hubble—all are most beautiful, almost unspeakably so.

3.4 On research as a nexus point between art and science

What of other points of nexus between art and science? More generally, and as always for me personally, both the arts and the sciences are expressions/outlets/cathartic vents for the urge to create, to perceive, to represent, to depict, to overturn, to transcend, to understand, to see or create or construct or synthesize the hitherto unseen.

To focus on the latter point: to see or create the hitherto unseen, this is what we do as professional physicists, knocking/beating/pushing against the boundaries and limitations of our understanding, the boundaries of our appreciation, the boundaries of our knowledge, the boundaries of our perception, the boundaries that form an interface between what we think we know and what we do not know.

By the way, some non-physicists are surprised to hear that the process of physics research can be very "organic", in a sense that I now outline. As physicists we throw up ideas, we argue for hours, we argue and search for days, we argue and search for weeks, we argue and search for months, tossing up physics ideas and hunches and leads and "running them through the mill". I'll throw something up and my colleague will shoot it down; my colleague will throw something else up and I'll shoot it down, or at least modify/evolve it; and we evolve and evolve and evolve until we reach some sort of distilled essence, out of this communal research effort. And this process, as I experience it almost every day as a working physicist, the essence of this creative process is not too dissimilar to the process of artistic creation which I observed between several members of the artistic group creating the cluster of illuminated and aurally immersed pods that now surround us ... thrashing ideas around, following hunches, evolving, evolving, evolving, collaborating, pushing the boundaries, creating that which has not been created before, a new beauty. It's all research—be it physics research or artistic research.

With a view to illustrating the parallels that we are here tonight to explore, to celebrate, I went to various background materials and texts which several of the artists in the group had provided for me. Let me focus on one such text, from the online biography of Marcia Jane, the projectionist. A line from this online bio spoke of her work as involving a process in which "intensive editing and the application of structure abstracts images away from real-world origins and combines them in new, graphic and rhythmic relationships".[5] Let us take this same text, written in the context of a creative art, in this case video art, and see how much alignment it might have, as a statement pertaining to the physical sciences. (i) "Intensive editing and the application of structure abstracts images away from real-world origins" ... this makes me think of physical laws. What are physical laws? One has an otherwise bewildering array of sense impressions, measurements in a suitably wide sense of the term—measurements of light, measurements of electricity, measurements of magnetic fields, measurements of billiard balls and springs, measurements of water waves and winds, planets and suns—and from this otherwise bewildering array of sense impressions, one tries to abstract the essence, "away from (the) real-world origins", to abstract a physical essence (rather than images) in a few beautiful laws of physics, to abstract the simple compressed beautiful mathematico-physical essence, to summarize that data in a beautifully concise/dense/essence-ial way ... this is the formulation of physical laws in the quantitative

[5] See Marcia Jane website at http://www.permutations.net/, accessed April 24, 2008.

sciences.[6] (ii) The latter part of Marcia Jane's statement, regarding combining these abstracted images into "new ... relationships"—does not this have a direct parallel with the idea of a physicist exploring a new and hitherto unknown/unseen prediction or consequence of existing physical laws?

Artists and scientists ... we work with different materials ... we might work with images, with sounds, with clay, with fiberglass, with measurements, with mathematical structures ... for the artist, the sum total of human experience is the raw material to be mined and mutated and evolved and morphed and metamorphosed and filtered and reworked and sculpted into art ... for the physical scientist, the raw material is a subset of the sum total of possible human experience, this raw material being provided by the physical world, the universe as a text, quantifiable measurements of the universe considered as raw material to be mined and mutated and evolved and morphed and metamorphosed and filtered and reworked and sculpted into science.

3.5 On extrapolation

Let us change tack, and talk about gardening, about roses. I really like gardening, I love growing/nurturing/tending roses, and particularly climbing roses. Suppose that the climbing roses in my garden were to grow one metre in one year. So, here's the observation: my roses grew one metre in one year. Suppose I was to conclude, as a brilliant deduction based upon this observation: "My roses grew one metre in one year, therefore they will grow one million metres in one million years". Now, if I were to say this, what would you say to me? You'd say, "You're mad/crazy/wrong".

What this simple scenario is intended to show, to exhibit in a slightly silly simple stark form, is the idea of the dangers of extrapolation,[7] of taking an observation, a harmless observation, and making an unwarranted extrapolation.

The history of the physics is littered with unwarranted extrapolations, the challenging of which has stimulated and continues to stimulate the ferment of ideas, a realignment of worldviews, a suspension of common sense, with the old common sense being discarded as a previous prejudice. Some

[6] In the words of Wheeler, "The yield of decades of research, hundreds of investigators, and thousands of experiments, turn out to be derivable from principles of almost trivial simplicity." See J.A. Wheeler, International Journal of Theoretical Physics, volume 21, pp. 555–572 (1982).
[7] The phrase "Dangers of extrapolation" is recalled from a lecture by Rob Hyndman that DMP attended at Melbourne University, in 1996.

examples: (i) The earth is flat. I don't know what you reckon, but the earth is flat, you go outside and the earth is flat. Play cricket, play lawn bowls, play football, and you behave/act/play according to the common sense that the earth is flat. The earth *is* flat. To conclude that the whole earth is flat because it looks flat in our immediate vicinity, is one example of an unwarranted extrapolation. The flat-earth hypothesis, the flat earth theory is fine if you are playing lawn bowls or cricket or football, but it's not fine if you're wanting to circumnavigate the earth. (ii) As another example, of a physical theory that represents an unwarranted extrapolation, one has the idea that matter is a continuum. Let me illustrate. Suppose that I am holding in my hand a glass of wine—I don't know about you, but when I look at a glass of wine it looks like a continuous liquid, a continuum, it looks infinitely divisible, there do not seem to be any gaps. This is another observation, another everyday observation (cf. the flat earth)—and for me to make the extrapolation, that because the liquid in my glass appears to be continuous, *therefore* it must be continuous down to the very smallest length scales, down to infinitely small scales—this extrapolation, like the roses and the flat earth—this statement that matter is a continuum down to arbitrarily small length scales, this is also an unwarranted extrapolation ... as the idea of atoms asserts.

And what each of these examples of unwarranted extrapolations is meant to show—the rose, the flat earth, the wine—is the idea that common sense (and common-sense physical theories) have domains of validity. Theories have domains of validity. The earth is close enough to flat, in sufficiently small patches, for most everyday purposes. The theory that the earth is flat, this is a good theory, provided that you do not try to push it too far, beyond its domain of validity. The idea that matter is continuous, this too is a good theory, provided that you do not try to push it too far. The idea that my roses grow about a metre per year, this is a good theory, provided that you do not try to push it too far.

(iii) Now as a last example, of the history of physics being littered with unwarranted extrapolations, let me get towards the point I am really trying to make, regarding "everyday notions of common sense". To this end, let me state a few tenets of common sense, a few statements of "obviously true" everyday common sense in the physical world. (iiia) Consider the idea of a "trajectory". As I wave my hand slowly through the air in front of me, one has the common-sense notion that at each instant of time my hand occupies a particular position in space, a particular well-defined position in space at each instant of time, a "trajectory". (iiib) As another example, of an "obvious" statement of common sense, if I am playing billiards, as my billiard balls bang/clack/collide into one another one never has the situation

that a given billiard ball spontaneously starts travelling backwards in time.[8] (iiic) As another example of everyday common sense, if I throw a tennis ball at a wall, I never get two tennis balls coming back.[9] (iiid) As yet another example of everyday common sense, if I laterally stretch out my arms, such that my left thumb points up and my right thumb points down, then it is meaningful for us to speak of "the state" of my left hand and "the state" of my right hand. This demarcation is rather anti-holistic, by assuming/asserting that one can indeed meaningfully speak in isolation of the state of each sub-piece of a given system.[10] (iiie) As a last example of everyday common sense, one has the notion that there is a clear separation between that which observes and that which is observed.

3.6 Quantum physics for artists

Now, all of the above examples of everyday common sense are like the flat-earth hypothesis, like the million-meter-megarose hypothesis—insofar as these are theories, and they therefore have domains of validity. All of these common-sense statements break down in the quantum world, the world of the very small.

Why is this so? Think about it. What is the smallest mass that we can directly apprehend with our unaided senses? Let's say that it's a thousandth of a gramme. What is the smallest time interval that we can directly apprehend? Let's say that it is roughly one hundredth of a second. What is the smallest length that we can directly apprehend with our senses? Let's say that it is roughly a tenth of a millimetre.

Well, the mass of one of the building blocks of atoms in our body, known as an electron ... this has a mass that is a million million million million times smaller than the smallest mass we can directly apprehend with our senses. Certain ultra-transient phenomena in physics (the decay of certain elementary particles known as "hadron resonances") can occur over timescales that are a thousand million million million times shorter than the smallest time interval that we can directly apprehend with

[8] Here, I have in mind physicist Richard Feynman's interpretation of anti-particles as particles travelling backwards in time. Adopting this viewpoint, one may consider the virtual electromagnetic process of an electron-positron pair annihilating to give a single photon, as an electron emitting a photon and then scattering backwards in time.
[9] In making this statement, I have in mind the famous "Klein paradox" of relativistic quantum physics.
[10] "Entangled" quantum states transcend this classical notion. In this context, I often introduce entangled "Schrödinger cat" states to my Honours Quantum Mechanics class in the following way: (i) I laterally extend both arms, with my left thumb pointing up and my right thumb pointing down; (ii) I then ask the class to consider the *superposition* of this state, with a state in which the direction of each thumb is reversed; (iii) The question "What is the state of my left hand" is thereby dissolved, in this rather strong analogy for an "entangled" quantum-mechanical state.

our senses. And an atom is "only" a million times smaller than the smallest distance we can directly apprehend.

It was bad enough when I tried to make an unwarranted million-fold extrapolation of my observation that my roses grew a metre in a year. So if one has a sub-atomic particle with a mass that is a million million million million times smaller than the smallest mass we can directly apprehend, or a particle that only lives for a time that is a thousand million million million times smaller than the smallest time we can apprehend, or an atom that is a million times smaller than the smallest length we can directly apprehend—why should our everyday notions of common sense hold true at such tiny levels, for distances/masses/times millions of times smaller than the ken of our everyday experience, upon which our common sense notions of space/time/causality are based? Our everyday notions of common sense have a domain of validity, and there is no *a priori* reason why these everyday notions of common sense should extrapolate down to describe masses that are a million million million million fold smaller than the smallest mass we can directly perceive. Again, there is no reason why all of our everyday notions of common sense should necessarily be operative or meaningful at the level of atoms and subatomic particles, where a billionth of a second may be an eternity—there is no *a priori* reason why, at the level of atoms, a million times smaller than the smallest thing we can see, there is no reason why our everyday notions of common sense should hold true.

So let us zoom into this quantum world, let us zoom in to the size of atoms or smaller, at least a million times smaller than anything we can directly apprehend, let us zoom into this quantum world. Again, there is no *a priori* reason why our everyday notions of common sense—those tenets of common sense that I mentioned before—there is no *a priori* reason why they should not break down, because physical theories have domains of validity and cannot be extrapolated too far. Indeed these everyday notions do break down—in many cases spectacularly so—and this, my friends, is the quantum world.

Welcome to the quantum world. This is where world views decay, where we transcend everyday common sense. Things are counterintuitive, as they should be. Remember the roses—it would be arrogant, implicitly arrogant, to assume that common sense should extrapolate down to this quantum level. Quantum physics *should* be weird.

Having zoomed down to this quantum world, we have a different world, different rules, a different game. As Marc Rogerson aptly put it, "Normal thinking is suspended, we have transcended the paradigms that we know".

3.7 Welcome

And so here we are, we scientists, we artists—we artists, we scientists—anticipating an installation, immersed in an installation which is a metaphor for this counterintuitive quantum realm, transcending the paradigms that we know. The matter and the light and the sound, in this space, is evocative of the quantum world. As one example, this is an interactive installation, your presence changing the space in a non-intuitive way, as a metaphor for the idea that in quantum physics there is no clear distinction between observer an observed. But enough—I do not want to speak in detail about the installation, let it speak for itself, to each of you as individuals.

As you enter this space—I know that you are physically here already, but as you enter this space in a more total way, I want you to feel/remember/re-experience a childlike sense of wonder, that childlike sense of wonder that you might feel when you gaze at a beautiful pattern formed by a twirling tendril of smoke, or a particularly singular cloud formation, or a delicately veined leaf, or an ant (pondering the size disparity as you watch the industrious ant striding around). The sort of childlike sense of wonder that you might feel when you stare at a particularly pretty bolt of lightning, or when you stand gob-smacked by a particularly poignant painting or measure of music, a sublime sculpture, a gorgeous mathematical theorem, an exquisite equation, or a beautiful physical law.

May you feel this childlike sense of wonder, this childlike open mindedness, as you approach this installation. May this installation overwhelm your senses. May it overturn intuition. May it strengthen the bridge between science and art, such that each inspires the other. May it transcend language and concrete representation. May its beauty both challenge and inspire.

4. The Unobservable in Art and Science, by Marc Rogerson

4.1 Creation

The moment of creation is a tricky subject.

It has pre-occupied far better minds than mine and, I dare say, as an area of enquiry, it hasn't finished its run yet.

Any artist or scientist can't help but to look back with envy and longing at moments in history when the epiphanic moment has struck some lucky ideological forebear.

Luck? Luck or design? Design or serendipity? Artistic or scientific creation as a manifestation of inner genius or the catching of the plump apple of chance?

The contemplation of this moment has to be accompanied by a quiet thrill that such moments of creation are tucked away, hidden around us too. Serendipity midst deliberate process, synchronicity popping of a hard, muddled, day, a eureka moment rumbling just below the surface. It is probably, in part, a drive to practice in the arts and sciences and compels the toiler to keep going.

The attempt to penetrate a scientific problem can give an unexpected serendipitous yield into an artwork. Was it luck or design that delivered the fruit of da Vinci's toil in the study and sketching of a sphere (for the sake of scientifically understanding its properties) into the skills he needed to paint the Mona Lisa's head perfectly in the round? Well, I find it too beautifully happenstance to weigh the creative moment down by the idea of pre-meditated design. This example, of course, draws on a moment in the working life of one of the most famous minds and one of the most famous paintings. It is, however, in the daily business of the nature of art and science that I'm interested in finding the parallels and differences.

The purpose of this text is to attempt to define, via science, a different, hitherto unexplored definition of the moment of creation. I shall attempt to go beyond the ideas of study, work, serendipity, design and luck into the provocative and intoxicating area of unobservability in quantum physics and its effects on creativity. I shall consider this both generally and in the context of a particular sculptural project that attempted to consider ideas in art and science.

4.2 Quantum mechanics to the wide-eyed innocent

The sheer mystery of both celestial and quantum mechanics has held a grip on the popular imagination far different from the other sciences. The practical updates in chemistry, biology, engineering and so on comfort the non-scientific world with the assurance that we're all moving forward in a fabulous, utilitarian congo line—adding new members to a steady procession of goodness and practicality. But the seeming arcana of bent space-time versus the uncertainty principle shocks us. The more we know, the more bizarre it appears to be. This can be a deeply emotional concept for the artist who's been without religious mystery to inform his work since the systematic unveilings of the enlightenment in the 18th century. Gradually, with the sheer exoticism of the science of the sub-atomic, a world appears that can feed a mind primarily interested in aesthetics.

I was having a cup of coffee with a physicist friend when he nailed me by his penetrating (and probably exasperated) gaze. The evolution of our language dealt, he said, with ideas of understanding the world. Trajectories of flung objects, seasons, the elements and so on all contributed to the structure of our language and its attendant cerebral substrates. But the world at a sub-atomic level defies language. A table cannot have a superannuation fund; a tree has no anxiety over a publishing deadline. But this level of apparent mental and conceptual fluidity is needed to consider the workings of the world at a sub-atomic scale.

Considering the moment of creation in a materialistic world with all the accumulation of practical facts heaped upon it makes a grave picture. How ordered and dull. But suddenly mystery is allowed to occur again. It has been expunged and tidied from our imaginations by a good couple of hundred years of technological advance. Farewell ye gods. The mystery of a sub-atomic world where language breaks down needs a new species of imagination to consider entities bi-locating, time reversing, entities being unobservable and so on. Suddenly along with mystery there appears a possible reason to create art: the creation of the inexpressible into the expressed.

Which leads me to the creation of the Cluster exhibition:

4.3 Cluster

The creation of Cluster which David Paganin has so generously supported with his preceding text had a number of small, technical, aesthetic, historic and personal rumblings before the satisfying "pop" of the work as an idea came into being.

(a) Unobservability as a vast relief. It is a relief to be utterly unable to observe a quantum entity without robbing it of its mysterious ability to be in many contradictory states at once. It is a relief to be impotent in the face of nature. It is a relief to see our apparent omniscience take a knock or two as we tramp around the planet. An electron assumes dimensions of time and space to humour us, happy to be many contradictory things at once, it's even happier to be something that we can understand after beaming our inquisitorial photon at it. Lovely. What a relief. "Glad you could come to the party," it tells us. Anyway, enough of this anthropic irreverence… the idea of unobservability is the point of creation that informed Cluster's birth.

(b) But it doesn't work! I wanted there to be a slightly maddeningly counter-intuitive quality to Cluster. It should be frustrating. Frankly, it was. I could never get it to follow my commands. It anticipated my observation and changed itself accordingly. Fabulous, existential impotence at last!

4.3.1 General Description

Cluster was an interactive, kinetic, illuminated sculpture exhibition with soundscape. I invited two sound-art composers, Philip Samartzis and Dave Brown, to form a trio called Plump. Thereby we had spatial and time-based arts covered.

I wanted to have an immersive environment which responded to the visitor and reacted in a non-intuitive way. There would be no text but large, illuminated pods suspended in space with a soundscape generated from surrounding speakers and speakers internal to the cluster of the pods. Motion detectors triggered the switching of electric fans and audio speakers, the fans caused the pods to knock against each other and thereby switched lights inside the pods.

The visitor, upon entering the space, could find the installation in a state of stillness, darkness and silence, or in total, animated, illuminated, noisiness. Perhaps somewhere in between, however, the

approach of the visitor changed the combination of the above kinetic, illuminated and sonic aspects of the piece.

If you walked towards a cluster of pods a fan on the other side of the room may be activated whilst someone else in the room may activate a speaker in a pod near you. The sound artists had their compositions on C.D. loops with Dave Brown's emanating from within clusters and Philip Samartzis' surrounding the installation.

By having the lux levels on the motion detectors finely adjusted, they may have or may not have been activated by motion because the pods adjacent to the visitor may or may not have been activated, thereby creating the light necessary to activate the motion detector

All in all, there was life there but not as we knew it.

Aesthetically, Cluster was gently and slightly disturbing; the soft, floating pods were tactile and invited people to touch them, push them or mingle through them. But it didn't make sense. While not a sentient entity, it knew you were there.

4.3.2 The unobservable system

I wanted there to be a sense in the observer that there was definitely a greater idea informing the environment which no amount of observing could determine. Indeed, the harder the attempt to observe, the more the installation would react and change. The randomness of human agency brought the standard observer–observed nature of art exhibitions to its knees. The analogy of the subatomic world, whilst oblique, held true.

4.3.3 The forming of the pods

Ah my pretty pretty things. I formed the maquettes in clay over a couple of months while at the beach in Southern Victoria, Australia. The shape that I finally settled on had a quality of life bursting from its seams. Two lobes of a pod bulbously protruding out from themselves like the moment of cell division that one sees on T.V. documentaries as a child.

They were carved in polystyrene to the correct scale, coated and finished in plaster and then moulded in fiberglass. From this mould were pulled fiberglass-skin replicas of the original shape.

The next task was to illuminate them with a technique that pulsed light as a result of their motions. Simply suspending a globe on a wire which struck the electrode—both hooked up to 12 volts DC did the trick.

4.3.4 The performance

Cluster was performed as one large sound and light instrument. Drawing on the enormous experience of Dave and Philip as improvising musicians, the piece came alive as a sometimes jostling sometimes supremely calm manifestation of time–based and spatial arts.

4.4 Mystery regained

As an artist I have found the contemplation of the ideas supporting quantum mechanics to have been as nourishing as Christianity once was to a pre-enlightenment world. The use of art to communicate something at which traditional language fails is an enormous increase in the validity of art and its departure from mere aesthetics into something else. The observing of the unobservable.

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Biographical paragraph for David Paganin

David Paganin is a theoretical physicist from Monash University, who has worked in a variety of areas spanning the entire spectrum from the fundamental to the applied. Areas in which he has published include quantum vortices, superconductivity, superfluidity, non-linear quantum fields, topological defects, Bose-Einstein condensation, X-ray imaging, electron diffraction, tomography, medical imaging, polymer scaffolds for tissue regeneration, next-generation lithography for the manufacture of integrated circuits, microscopy, holography, atom optics, condensed matter physics, neutron optics and visible-light optics. DMP always strives for original (and preferably simple) solutions to highly interesting problems of fundamental and/or practical significance. He has a sustained record of working closely with experimentalist colleagues, with a view to seeing his practical theories "made real" via tangible applications to the physical world. In addition to striving to be the best researcher he can be, he strives to be the best teacher he can be, and to help nurture the careers of younger colleagues. Since graduating with a PhD in December 1999, he has written over seventy papers for peer-reviewed international physics journals, together with a book: D.M. Paganin, *Coherent X-Ray Optics*, Oxford University Press, New York (2006). This 400-page monograph is the first of its kind, in the area of coherent X-ray optics. It gives a thorough overview of the conceptual and mathematical foundations of the discipline, from a unified theoretical perspective. DMP's works have attracted well over one thousand citations in international journals. Several of DMP's key first-author results have formed a direct platform for research papers by other groups, in both academia and industry, from over twenty institutions worldwide (e.g. Oxford University, UK; Advanced Photon Source, USA; National Institute of Standards and Technology, USA; Carnegie Mellon University, USA; Brookhaven National Laboratory, USA; Hewlett–Packard Laboratories, USA; Intel Corp., USA; HREM Res. Inc., Japan; University of Sydney; University of Newcastle; University of Melbourne; Victoria University; CSIRO; La Trobe University). A company was formed to commercialise some patented work arising from his PhD studies (Iatia Vision Sciences, www.iatia.com), who invested over $13 million in the technology. Major awards include an R&D100 Award (2002), a Monash Faculty of Science Early Career Researcher Award (2007), and a Monash Faculty of Science Dean's Teaching Award (2008). He currently supervises seven PhD students, four honours students and two postdoctoral fellows. In his spare time he likes to compose sound art, study ancient Greek, and tend his roses.

Biographical paragraph for Marc Rogerson

Marc Rogerson is a sculptor and painter whose practice involves illuminated sculpture, architectural–sculptural installations, abstract painting, figurative painting and portraiture. Formally untrained, he started executing mural commissions in 1988. The company Fresco and Co. was formed which swiftly outstretched the original brief of murals and extended its practice into site-specific sculpture and mixed media. The model for the company was the renaissance-style artisan studio with a team of diverse artists under the aegis of a studio director. A major collaborator during the first 5 years was Dr. Michael Vale (now lecturer at RMIT) and artist Daryl Millard (now resident in the U.S.A.). Commissions at this time were primarily coming from architects and interior designers. A theoretical approach incorporating the architectural language and history of a space with Marc's aesthetic sensibilities created a body of work, over a decade, that attempted to add a level of visual spirituality to the built environment. Some clients were Shell, Ford, Telstra, the Victorian Government, minor nobility in Indonesia and Kadadu national park. After 10 years of architectural commissions, a major break from excessive diversification of media and the burden of commercial briefs was needed. From 1999, Marc started to develop prototype illuminated sculptures in media ranging from painted calico, fiberglass, slumped glass, cast resin, plastics, found objects and smashed car window fragments. Marc's practice has been public with exhibitions and commissions for commercial spaces and private in the creation of bodies of work for their own sake. Solo exhibitions include: Paintings from Classical Tragedy, Carlton (1998); Italian Men of Carlton, Carlton (2000). Group exhibitions include Rebirth of the City, Melbourne (both as curator and exhibitor, 1996); Plastic Fantastic, Fitzroy (1997); Cluster by Plump, Melbourne (2008). In 1999 Marc curated, at the invitation of the Dutch Consulate, an exhibition of Dutch-Australian painters.