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The language of invisible worlds
Liliane Lijn

I want to walk through the transparent world of photon light,
work with the source of light, capture electron images.
My echo-lights are silent spherical reflections, photon planets echoing themselves.[1]

In the spring of 2005, I was awarded a residency at the Space Sciences Laboratory (SSL) at the University of California, Berkeley, through Arts Council England's International Artist Fellowship Programme[2] My path to Berkeley was traced in Paris, where I studied Archeology and History of Art at the Sorbonne and the Ecole du Louvre and at the same time began to work independently as an artist. There, in the autumn of 1961, I was introduced to science by a South African poet masquerading as a biophysicist.

Sinclair Beiles, a denizen of the Beat Hotel, rue Git le Coeur, knocked on the door of my Quai d'Orsay rented apartment and asked for Takis, a Greek sculptor of magnetic fame, with whom I shared my life at that time. Takis was out. I offered Sinclair coffee and he told me of his latest experiments extracting life from the tobacco mosaic virus. I asked him where he worked, imagining a laboratory

[1] From *Electron Notes,* Liliane Lijn, London: Signals, October 1964.

[2] 'Art and Space Science at UC Berkeley' through which this residency was awarded, was a collaboration between the Arts Council's Interdisciplinary Arts Department, the Leonardo Network and the Space Sciences Laboratory, with support from NASA.

of some sort. ‘In my room at the Beat Hotel’, he replied. Later, when I told Takis about his physicist friend, he laughed. ‘What physicist? You mean that mad South African poet!’

In the dense time of my first two years in Paris, events real, imagined and dreamt merged into the magma of my own magnetic core. When I met Takis, he was lurking suspiciously at the Café Deux Magots, hunched over one of their beige and green woven rattan tables, smoke curling like a magic curtain masking his face. I was with my Parisian boy friend, the Surrealist painter poet, Jean Jacques Lebel. Jean Jacques prefaced his introduction of Takis with a warning about how this undependable Greek was on drugs and sat daily at the Deux Magots to pick up girls. Takis was charming and asked to see my work, so I invited him to my studio.

I was working on puzzles. I would buy a jigsaw puzzle, take it apart, paint each piece separately to erase all clues as to how to connect them and then try to put the puzzle together again. Takis was fascinated by this project of mine and told me it was highly original and that he would, if I wished, teach me the lost wax technique so that I could develop my idea in three dimensions.

This promise of learning was the premise of our relationship and the beginning of our friendship. I began to visit Takis regularly in his claustrophobic three room apartment on Boulevard Montparnasse, where he cooked his wax on a small Bunsen burner, never opening a window, the stench of wax, Gauloises, cabbage, piss and sweat blending into what became my main olfactory memory of Paris. On one of these visits, he appeared more than usually excited and showed me a small metal plate with a nail hovering at the end of a string. ‘Look, this is my latest invention.’ The nail was floating, trembling as if alive. ‘Guess how?’ Takis insisted. I gazed at this small miracle without seeing the obvious and ventured a guess: ‘Did you use mathematics?’ Takis explained that he was using a magnet to attract the nail but the string that it was tied to held it just short of the magnet, so it appeared to float. He was ecstatic. With this idea he had revolutionized sculpture.

Through Takis and Sinclair, who was editing *Naked Lunch* for Maurice Gerodias’ Olympia Press, I met William Burroughs, Brion Gysin and Gregory Corso with whom I immediately became friends. Gregory loved my *Skyscrolls*, wax gouache and ink paintings of landscapes and creatures of the sky. We would often visit them at the Beat Hotel where one walked up narrow stairs, peering through seemingly transparent walls, in a haze of

incense and pot. Sinclair came to visit us daily in a state of extreme agitation because Takis was soon to lift him magnetically into space. He insisted Takis buy him a helmet to protect his brain from the magnetic radiation.

On the opening night at the Iris Clert Gallery, Sinclair was suspended in space by a powerful electromagnet and, from this quivering airborne position, read his poetic *Manifesto*. The moment was electric, the small Gallery packed as Sinclair declared that as 'the first poet in space' he demanded that all atomic weapons be dismantled and given to artists to create with them monuments to peace.

That was my initiation into space science. My work at the time was preoccupied with the sky from which my interest in light was soon to develop. I began to explore new materials and technologies in a conscious effort to 'work with the source of light'[3] and started reading books on optics and physics. I particularly liked the diagrams and photographs in the monthly journal *Scientific American* and discovered that many of the words used were new to me. I felt like I was reading a partially foreign language, the language of invisible worlds.

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Now, 45 years later, here I was being given the opportunity to spend three months working side by side with people who daily investigate unseen worlds. In the intervening years, my interest in science had remained constant although it may have ranged across wider areas. In 1983, Thames and Hudson published my book *Crossing Map*[4] in which I wrote of the end of our society and imagined it transformed into a world in which human beings were disembodied energy entities. I had hoped then to explore my original ideas about the relationship between atomic particles and human behavior in collaboration with a scientist but found that hard to arrange. This was in 1968, well before the encouragement of the Arts Council through programmes such as this residency at SSL or Art and Science Research Fellowships.

SSL is perched high above the rest of the Berkeley campus on a golden brown dome of a hill. This hill is high

[3] From *Electron Notes,* Liliane Lijn; Signals October 1964, London

[4] *Crossing Map*, Liliane Lijn, published by Thames and Hudson Ltd in 1983.

enough to be visible for miles and far enough from the main part of the campus to seem isolated, even forgotten. This seemed to me to be an apt metaphor for the position of Science in our society. Although plainly visible, if you ask for the Space Sciences Lab on campus, no one knows where it is. It is reached by a bus called the Hill Line which shuttles back and forth between SSL on Gauss Way and the Hearst Mining Circle at the east

end of campus. Once I had found the Hearst Mining Circle, whose sonorous name recalls the original function of the campus as a mining school, and convinced the bus driver that my assorted paper identity cards were bona fide, he became my morning friend. Clinton, young, black and possibly athletic, waited for me behind his steering wheel every morning, beyond the normal 15 minutes to or past the hour, in case I arrived late, panting up the hill lugging my newly purchased white backpack. Some days he arrived as I sat waiting on a sunny bench, reading the Wall Street Journal (which was thrown daily and unpaid for on the path leading to the house where I lived). Catching the shuttle or, more likely waiting for it, was my morning ritual, arrived at by a walk from my apartment on Delaware street and Shattuck, the Broadway of downtown Berkeley, across the richly verdant campus with its towering redwoods, eucalyptus, flowering perfumed magnolias and banks of blue and white agapantha. Each morning I would find a new way to walk through the campus to the Mining Circle, slowly discovering all the varied pathways and buildings, each dedicated to different aspects of knowledge and human endeavour.

One thing about the Space Sciences Laboratory, which I learned from Jackie Wong, an astronomer and my charming guide at SSL's Center for Science Education (CSE), was that the Laboratory had no cafeteria so it was important to pack a lunch every morning. In fact, so important was this missing amenity, that a constant 'leitmotif' of the day was the continually wafting aromas that issued from the microwave oven in the office I shared with four education scientists - Jackie Wong, Darlene Park, Karin Hauk and Karen Meyer - and which was also used by scientists in adjoining offices. Memorably overwhelming was Bryan Mendez's daily, late afternoon popcorn visit. In our office, a table was often spread with the remains from a conference lunch or a seminar's tea, with little stickies inviting us to enjoy. And then every Tuesday there was tea and biscuits in the Conference room, an informal 'Kaffeeklatsch' meeting of minds.

On my first day at SSL, Jackie accompanied me into the building, pointing out different details and exhibits as we went. The astronomical mosaic on the floor at the entrance, the rocket and satellite parts exhibited on the ground

floor, the Conference room and then my place of work. Room 233 was large enough to accommodate six people, working in a semi open-plan environment, small offices made separate and somewhat private by approximately 8ft high dividers, with a larger space in the middle. During the period of my residency, every time I met someone outside the Laboratory I would be asked the same questions. On hearing I was an artist, they would immediately ask if I had a studio and only then ask what I did at the Lab. The question actually was, 'Have they given you a studio?' 'No', I answered, sort of amused. 'I have a desk and a computer.' In fact, my studio *was* the computer.

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The first scientist I met was Stephen Mende. I was accompanied again by Jackie, who said she never got a chance to speak to any of the research scientists and was curious to witness this first meeting. Stephen, a senior research scientist, had the air of a European who had settled in the States. In fact, he mentioned he was just about to go on holiday in France after giving a paper at a European Conference. He was slight and somewhat nervous. I had the feeling that although he had an interest in art, he was at the same time diffident and concerned not to waste too much time talking to me. But he then took the time to look at my website, while I explained briefly what my work was about. He commented that my work was 'all so solid' compared to the phenomena that he studied: the aurora borealis, the solar wind and the earth's magnetosphere. He wondered where we would find common ground. I explained that I was interested in immaterial phenomena such as light but had decided to manifest light through matter, the immaterial within the material. But if one thought about it even what appeared solid wasn't really, was it? I wondered why Stephen Mende chose to research the aurora. He told me his latest research was looking for what caused auroras and magnetic storms. I left him, my head buzzing with confused fragments of his

complex explanations, imagining the Sun making love to planet Earth, as its wind stealthily poured solar substance down the Earths polar opening. I asked him if he would allow me to read the paper he was about to present and, on further thought, decided that it would be a good idea to video my meetings with scientists. Video would act as a back up memory. Of course, at the time, I didn't realize just how difficult it would be to act both as interlocutor and cameraman; participant and observer.

Jackie sent out email invitations to a reception for me on the 3rd of June, during which I would give a seminar, and I decided to invite some friends and other people whom I had been encouraged to meet in San Francisco by Kathelin Gray, a London colleague. By coincidence, I already knew one person on her long emailed list of 'people to meet', the Swedish painter poet Aggie Faulk. The last time I had seen Aggie, had been in the summer of 1997 on her return from South America, where she had flown to recover her balance after her husband Asa's death. She was surprised and pleased to hear from me and invited me to come and meet her and Jack Hirschman the next day at Café Trieste, the 'in place' for poets in San Francisco, and then go on to a poetry reading. She was amazed I hadn't heard about Café Trieste. It was just opposite City Lights Bookshop and, she added, it was practically their living room.

The reading was later at Sweetie's Bar, on Francisco between Mason and Powell, and was given by the poet David Meltzer. His name was familiar to me. The devious complications of life! Of course I knew David. I had met him in and his whole family in1974 while visiting Asa and Pip Benveniste in their house in London's Camden Square, the same house where I now live. David and his family were there, spending the summer with them. We had come for dinner that

evening. I loved their house because I loved them, and because I was editing my film *What is the Sound of One Hand Clapping* there in Pip's cutting room on the third floor, a room that would later become our children's bedroom.

Asa Benveniste was a poet and the publisher of Trigram Press. I had first met him in 1968 through Sinclair Beiles. On one of his frequent London visits, Sinclair had shown me his manuscript *Deliria*, written during time spent at Kingsley Hall (Ronnie Laing's experimental therapeutic community for those designated mentally ill) and asked me to illustrate it. I responded with a series of drawings I called *Neurographs*, which were made using Letraset transfers of electronic symbols. Delighted with my

illustrations to *Deliria*, Sinclair had approached Asa at Trigram Press.

Sinclair later described their meeting as difficult. Asa was not acquainted with his work so he'd had to show it to him. The other side of the story was revealed when Asa said, 'He came with a large suitcase and dumped it out on my floor!' Needless to say, Trigram did not publish *Deliria*. Nonetheless, Asa and I became friends.

I thought of all this while listening to David's rapturous reading. I also remembered that I had read some of David's poetry since I owned a copy of *Yesod*, a beautiful book Asa had published of David's poems. He had grown older and an illness had left him almost unable to walk but his reading was full of passion. It was also well attended, with people seated in the small space dedicated to the reading, and further back, people crowded around the bar, all of them also listening. After David, his friend, the poet Jack Hirschman read. Jack had been Asa's best friend. Aggie had met him while Asa was still alive and living in Hebden Bridge, where he and Aggie lived together after Asa had left Pip. Their love affair had been a drama but the drama subsided and their love endured. A cabalistic trickster spirit, Asa knew that drama was the very stuff of poetry. Jack's poems were great and his wonderful toothless face so expressive, his voice so melodious that all that followed after these two bards felt somewhat thin. In fact, the large audience turned out to be made up mainly of other poets, who, after the evening's invited poet, rose up each in turn to read one poem.

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I noticed that although there were many women scientists working in CSE, the science education and public relations area of the lab, there were very few women among the research physicists. One of the most senior amongst these was Janet Luhmann. I met Janet twice. Firstly, when she asked to meet me soon after my Seminar, apologizing for not having had time to attend it and stressing her interest in art, which she said, she had nearly taken as a major in College. The second time, I asked her if I could come and interview her on video. She was not entirely sure she wanted to be filmed but finally did agree. Prior to our first meeting, I had seen a number of NASA posters relating either to satellite missions or Space Weather. They had all seemed crude and badly designed to me. It was hard to believe that with all the amazing imagery coming from Space, this was the best they could do. When Janet told me about her interest in art, I mentioned this to her, my dismay at the inability to visually convey the magnificence and wonder of outer space. The banality of the posters I had seen was a dumbing down of the fascinating complexity of Space Research. My criticism disturbed her and she immediately showed me her own project STEREO's website. She was proud of its artistic qualities and thought that scientists really were creating art, now

that they could use computers to draw cartoons and create animations from their data. As an undergraduate, she had found it hard to decide whether to major in Art or Science. She came from a very practical family and her practical side had made her choose Physics. She had thought, at the time, that she would be able to continue her passion for art as a hobby but, of course, scientists don't really have spare time. She looked up at me with her intense blue eyes and her rarely bestowed but charming smile. She told me about her idea to convert solar data into music. She had commissioned Roberto Morales Manzanares and David Bithell from the Center for New Music and Audio Technologies (CNMAT) at UC Berkeley to work on this but was not completely happy with the result. Janet had hoped to hear something more melodic, a symphonic interpretation using violins and other classical instruments and was not at all convinced by the more ambitious ideas of the composers who had written interactive software with which one could literally play with solar data on a number of frequencies and with a choice of synthetic sounds.

Soon after giving my introductory seminar, I received an email from John Vallerga. John is an astronomer working on Adaptive Optics, complex optical systems which detect phase errors in the atmosphere to inform changing mirror surfaces for telescopes and other instruments.

John wanted to see me to talk about an idea that he thought might interest me. He said that he had enjoyed my talk and I remembered that we had spoken briefly afterwards. He was thin and wiry and spoke in a direct almost telegraphic manner.

'If you look out over the Bay area from here or, say, from the terrace, you will almost always catch a bright reflection of the sun off a window,' he said. I'd noticed this too. In fact, I enjoyed watching the car window reflections from the Lab, as the cars moved either north or

south along the motorway in distant Berkeley. 'The sun' he said, holding his thumb up to the window, ' is half a degree. You can cover it with your thumb.'

He explained that his idea was to reflect the light of the sun in a controlled fashion so that, for example, someone standing on the Golden Gate Bridge would be able to see a luminous solar point that was reflected by us from SSL. We could use mirrors, diffraction grating or prisms. I said I preferred prisms and told him he had come to the right person since, as an artist, I had been working with reflected and diffracted light for years.

After an hour of intense discussion, we came up with a few ideas, one of which both of us liked. I thought we could put enough points together to make a mirror image of the sun; possibly a blue sun, which would be seen setting just above SSL. There was so much solar research being done here that a solar symbol seemed an appropriate installation. John was enthused. We had the ideas and he could come up with the technological solutions. What we needed was funding. We decided to discuss this with Isabel Hawkins, an astronomer and the Director of CSE. I saw Isabel briefly in between her frequent trips to conferences and her summer holiday. One evening, she invited me to her home for dinner with Jose Huchin, a Mayan archeologist from the Yucatan. On that occasion, meeting her husband and her two daughters, I realized just how stretched she was between her roles as mother and wife and her full-time career as an astronomer in Science Education. Women who want to live full lives and have families as well as careers must become both acrobats and jugglers, experts at balancing and handling more then two hands can hold. Isabel had both knowledge and understanding in her field but also the ability to impart that knowledge in a manner that was clearly accessible to ordinary people without watering it down. Isabel, like most really good scientists and artists, is a lateral thinker with an imaginative and open mind. I was impressed by the correlations that she and CSE were making between contemporary and ancient astronomy and by her interest in the cosmologies of earlier pre-scientific cultures.

Thinking more about 'archaeo-astronomy', I thought of ley lines, the name given by Alfred Watkins in 1921 to the energy fields, or pathways, linking important sites in Britain. And how these ideas seem to reappear in various cultures, including Chinese philosophies and 'New Age' literature and thought. Observing the surrounding hilly landscape, another idea for the solar reflection project came to me. I thought John Vallerga and I could use reflected sunlight to outline and illuminate the

interface between earth and sky. John agreed that this concept was not only more exciting but also more easily achievable. Sunlight is taken for granted and with this installation we hope to create a new awareness of the beauty of our star. We will be using light to draw people's attention to the horizon. Dawn and dusk are the mysterious moments that often hold people in awe. They are moments in which we become aware of the edge of our planet and of its connection and relation with the cosmos.

John had also taken me to a storeroom where he kept ‘failed’ instruments, so called because they might have been contaminated and thus were useless. He wondered whether I might be able to find a way to use any of these pieces of equipment. I was drawn to a case with rubber gloves attached, a ‘clean box’. I thought of filling it with found objects from the Fire Trail, a five mile path that wound its way down through the woods to the lower campus. The ‘clean box’ was normally used to manipulate sterile instruments that were going in to space. They need to be sterile in order not to pollute outer space, but the same instruments are also tested on their return to Earth for what they might have brought back.

To correctly observe and analyze scientists need to keep things separate. But, as an artist, I wanted to contaminate their ‘clean box’ with the familiar stuff of ‘earth’ as a reminder that ‘nature and science are not opposites’.

Here at SSL, nature is the object of research. Objectification creates a dichotomy between nature as subject and nature as object. Observation necessarily entails distance. Space Science definitely has that distance or objectivity. Even the design of Addition[5] and its functionality seem to isolate it from the natural world, or should I say the living, changing, biological world, via air conditioning and fluorescent lighting. Moreover, to see invisible worlds, to obtain information about the intangible, science often no longer employs direct experience at all. Thus, speaking to a young researcher who was working on the aurora, I learned that all of his information is obtained through numerical data. He has never actually seen the phenomena he is studying; never perceived the aurora with his own eyes.

For reasons such as these, I thought the ‘altered clean box’ could be an interesting object and my gut feeling was to find a way to infiltrate images of nature into this apparently closed world of science. In video this would entail splicing my interviews inside with outdoor images of trees, hills, sky and water. It is ironical that the more we find out about the structure of the cosmos, the less use our own sensory equipment is in gathering this knowledge, and the more indirect our experience of the cosmos becomes.

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‘Magnetic fields generate energy’, Ilan told me. ‘All the energy coming from the sun isn’t just coming from the solar oven, but from magnetic field energy.’

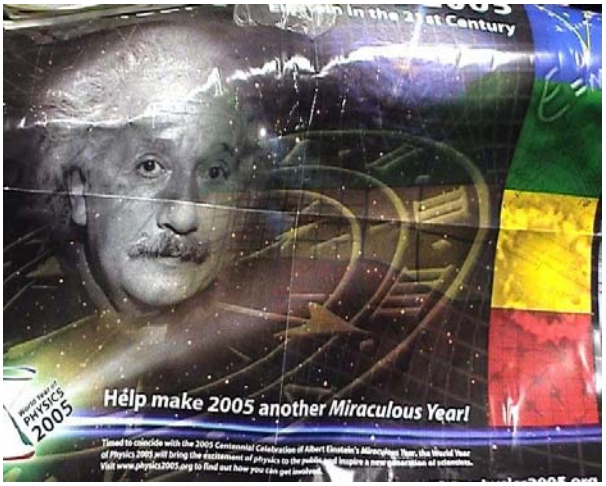
On the day he introduced himself, Ilan told me he was one of the few physicists in our building, and asked me if I wouldn’t like to have a cup of tea. He always kept tea and cake in his office across the hall and before I knew it we were having lunch on one of the small open terraces overlooking the Fire Trail and a magnificent view of the Bay area

[5] SSL is located in two buildings. The original laboratory, The Samuel Silver Space Sciences Laboratory, is called Silver and the new addition to it, where I worked, is simply called Addition.

and San Francisco. We had discovered that my mother had grown up in Poland, where Ilan was born and from where his parents, during a political lull in the 1960's, had immigrated to Israel. Ilan, possibly in his 50's, with an open face, large sparkling eyes and a ready toothy smile was what my father would have called a 'landsman'. Since, I had always felt singularly detached from any country, we were 'landsmen' in our 'outsiderness'. Those who do not belong always recognize each other. I told Ilan about the film I had made about my mother. How her parents had fled Moscow after the 1917 revolution, fled to Poland where she grew up in a suffocating atmosphere of anti-Semitism. He wanted to know how they had survived. I explained the curious coincidences that saved their lives.

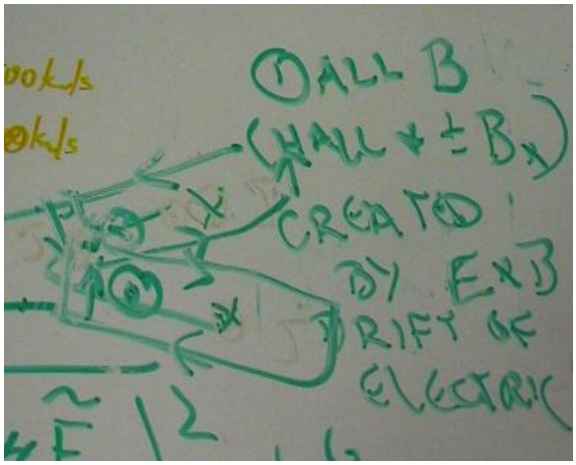
'Life is a matter of chance,' Ilan said, 'Listen to my story.' As a young man, Ilan's father had, on impulse, suddenly left his family in Poland to go and fight with the Republicans in the Spanish Civil war. He was there for a few years and when he returned to Poland after the war, he discovered that his whole family was dead. A moment's impulse fed by youthful idealism had saved his life, since the rest of his family, the whole village in fact, were killed by the Nazis. Ilan was born in Poland where his father had remarried. In the 1960s his family had been able to emigrate to Israel and so Ilan had become Israeli. He was very musical, played the cello and as an adolescent had applied for a scholarship to study in the States. His teacher who was preparing him for the exams knew the ropes and told him not to bother to prepare his cadenza since they never asked for one, but just this time, they did. Exasperated at not receiving his scholarship and, in a typical adolescent sulk, he decided that if the world of music didn't want him, he could also do without them and he gave up his musical career. He had always loved mathematics, so now he turned his mind to science and discovered, he told me, that the Fourrier Transformations were even more beautiful in mathematics than in music.

Since Ilan was leaving in a few days, he agreed to be interviewed, adding coyly that he was frightened of the camera. 'It is not an instrument of torture', I assured him.



Ilan's office is chaotic. It is almost exactly as one might imagine the den of a mad scientist or absent-minded professor. Books and papers are stacked or lie open on his desk. Paper cones of stale coffee and dirty mugs remain forgotten in a corner on the floor. Plastic bags are draped over spare chairs and one large brown paper bag sits open and

empty like a strange effigy. Crookedly taped to a filing cabinet, a crumpled poster celebrating Einstein's centenary reminds Ilan that he has yet to make a great discovery. I place him in front of his books and papers and he begins to tell me about his life and becoming a physicist and how he came to work in Berkeley. Suddenly, having explained Fourrier Transformation and actually intoned the various frequencies, Ilan says that he must leave the room for a few minutes and so abandons me. I look around and decide that this room holds a mirror to some part of the man who inhabits it. I film the room slowly and as I focus on his whiteboard covered with energetic sketches and equations, Ilan returns. Yelping, he protests. 'You're filming? But this is nothing! Not science, these are just cartoons!'

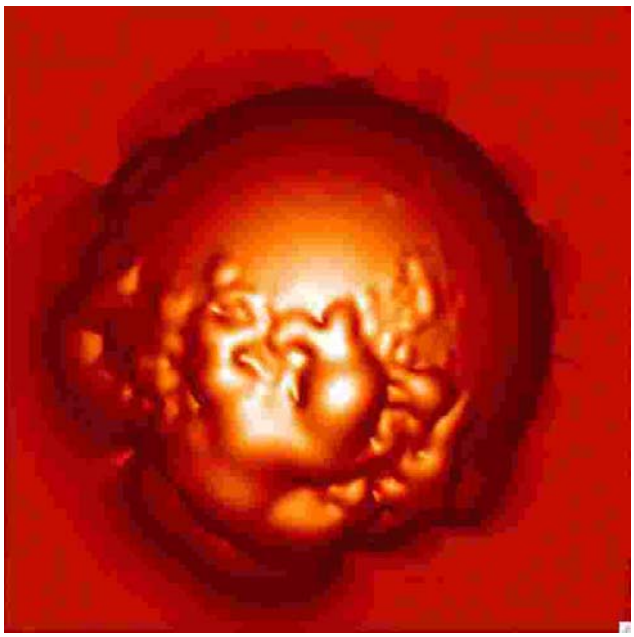


The whiteboards are ubiquitous. Every room certainly has at least one and John Vallerga pointed out to me that in Silver[6] there is a very long white board in the main corridor, the one with a view of the Bay area. Everyone who passes it, checks out what's new on it and then writes or draws a response to someone else's jottings. I have discovered that space scientists communicate both with their hands and with cartoons. I love the cartoons. Janet may feel that the animations are more artful but I sense real art here, in these crude and lively sketches. They are visual representations of scientists' thoughts and, although the thoughts are very different, they are akin to artists' working sketches.

David Brain's area of research was Mars, magnetic Mars and, in particular, the magnetic crustal fields of Mars. When he first said 'crustal', I heard 'crystal'. Dave was very emphatic that *crustal* magnetisations were not anomalies, where most scientists believed that they were. Dave described the crust of Mars. The planet is 3400km in radius and the magnetic field is 40km deep. That is deep, he assured me. Somehow these areas of the Martian crust had become magnetized. I asked questions and took frantic notes. It was exciting because he was so passionate about his research. He answered all my questions, seriously, earnestly, as if they were not only interesting but possibly could lead to something important. I felt as if we were having a dialogue that might even uncover a new idea. Mars was no longer a distant orb. Its existence and physiognomy, its life and history, seemed urgent. Here was a new world to explore, possibly a planet that humans might live on one day.

[6] The original lab at SSL is referred to as Silver.

Dave likes to talk about how he teaches. ‘I always tell my students the basic rules which determine whether a planet has a magnetic field or not.’ And I think this is what he told me.



Global magnetic fields are generated from dynamos deep inside planets. There are three necessary conditions: energy (heat) inside the planet, some kind of rotation, and an electrically conducting fluid or magma. Mercury, surprisingly, has a magnetic field. Mercury also has magnetic rocks, a magnetized crust. Venus, on the other hand, has no magnetic field. Venus only barely rotating at all, since one Venusian day is equivalent to 243 earth days. Venus is also rotating backwards, clockwise. Dave explained that a possible cause was a huge impact. The other planetary bodies in our solar system rotate counter-clockwise so, possibly, Venus was blasted into switching direction.

Earth, as we might have guessed, is perfect. The Martian atmosphere is half of Earth’s and Mars may itself have auroras. In fact, there is new evidence of auroras forming above the magnetic crustal fields. What is so curious is that the global magnetic field maps of Mars show that crustal magnetization appears to be mainly confined to the ancient, heavily cratered highlands in the south. So there is a dichotomy between the Martian North and South. They are different and opposite. The boundary between these two areas is called the ‘dichotomy boundary’. This last fact seemed so strange, a planet clearly divided into two opposite areas, one much smoother and younger than the other. I asked how this could have come about and Dave spoke of ‘magnetic memory’. He said that magnetized rocks remember their position once they cool down. He thought that these rocks had become magnetized at a time when Mars had a strong magnetic field. Now, the field was practically gone but the rocks still remembered and contained, so to speak, the planet’s magnetic field.

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I had made a list of people I wanted to interview and decided to do some reading about their research. I read about the THEMIS[7] project which will do research

[7] ‘Time History of Events and Macroscale Interactions during Substorms’ (THEMIS) is a NASA project, which will be launched in October 2006.

on the aurora, disturbances in earth's magnetic field due to the solar wind, which is also a magnetic field. I now understood that the solar wind compresses the earth's magnetic field, pushing it or warping it over the earth and lengthening it away from the earth in the form of a tail. At some point there is a break in the earth's field and then a reconnection forming a new field: this phenomena seems to be continuous and possibly causes the aurora to appear. The auroras are also visible at lower latitudes than they used to be. I looked at Bill Abbett's website and read a few of his papers in preparation for interviewing him. He described himself as 'an assistant research physicist who has a variety of research interests in the field of astrophysics, including the formation and evolution of magnetic fields in the convective envelope of stars like our Sun.' What was the convective envelope and how did it work? I began to make a list of my questions in preparation for my talk with Bill. I was not quite sure why magnetic fields seemed to be the main focus of interest. I liked the images on Bill's website. Particularly the drawings with small arrows showing direction of motion or flux, the white on black cartoons in his paper *Evolution of Twisted Magnetic Flux*.

Like Ilan, Bill Abbett came to physics after disappointments in a musical career. He had dropped out of education and bummed around for a while, forming a blues band with friends. Bill was a jazz, rock, blues pianist and composer but although they had played professionally, commercial success hadn't come their way. At some point, Bill felt he wasn't getting anywhere and had decided to go back to College and get a degree. He had always liked maths and physics and had somehow gravitated toward Space Weather and solar physics. We imagine scientists to be rational, assured even measured in their behaviour but Bill didn't fit into a preconceived mold. He seemed to think as he spoke, contradicting himself, and changing direction, explaining his research with many diversions and personal details. I found him totally disarming. He seemed to be battling with himself. Appearing insecure and self-deprecating, he was clearly brilliant and his research seemed to me to have an intuitive and profound understanding of where to look for the driving forces of the solar oven. Bill said that he was interested in the interface between radiation and convection zones. It seemed clear to me that the interface between two very different areas was the most interesting zone to observe, in that boundaries are always areas of turbulence and transformation. This metaphor seemed valid wherever one looked. Ilan had told me that the magnetic fields in the sun generated energy, and Bill's research investigated that same phenomena.

We tend to think of the sun as a nuclear oven, its source of heat the constant fusion of hydrogen into helium. Their research is trying to find out where the heat and light we receive is generated. It isn't, in fact, coming from

the nuclear oven, the radiation zone of the sun, because the photons and particles from that area take thousands of years to get to the next layer, called the convection zone. There were strange things happening in the convection zone of the sun and that was precisely what fascinated these scientists. One curious fact was that the chromosphere, at the outer edge of the sun, was so much hotter than the layers below it. This meant solar material in the convection zone was being churned about and made more energetic. Magnetic fields seemed to be doing that work.

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I noticed that each person who told me about the Magnetosphere, its relationship to the solar wind or magnetic field, told it in a different way. It seemed an excellent idea to ask a number of scientists to explain these phenomena to me on video. I could compare their stories, their viewpoints and the different ways in which they related the same facts, what each person emphasized and their attitude towards me both as artist and interviewer.

I had met Tom Immel, Laura's husband, at my Seminar and then met him again quite by chance. This time, I asked him if he would allow me to interview him on video.

Tom is a physicist and his research is on the particles in the upper atmosphere and the ionosphere. He uses far ultraviolet imaging of Earth from a number of orbiting spacecraft to give him a global picture of what is going on. I brought the CSE camcorder with me and the first thing it focused on was a book on one of Tom's shelves. Its title 'The Science of Light' was printed in gold letters on its spine. I asked him if he could open it. He pulled open the hardback cover, unfolding long paper diagrams of ionised atoms in all their different states. It was a University library book, taken out some years ago, which, he casually added, he had forgotten to return. I wouldn't have returned it either, I thought.

I found Tom fascinating, in his appearance and mannerisms and in what he told me. Tall, thin and oddly fluid in his body movements, he spoke of gravity's effect on the waves and currents. I asked, 'what currents?' thinking that perhaps he had begun to speak about the sea. He was still speaking about the atmosphere. He explained that Earth's atmosphere had currents and tides of its own, that the lower atmosphere affected the upper, rainstorms affecting the ionosphere. I had never considered this possibility. I realized how little one thought about the complexity of our planet's atmosphere and the exquisite equilibrium of its many forces.

I asked him to describe and explain the Earth's magnetosphere, its origin and function, and to describe the interaction between it and the solar wind and solar magnetic activity. He responded to these questions with a small moan of exasperation, that this was not his subject but he could venture an answer. The explanations, which followed were very complex because he brought

relativity into it. He said there really were no magnetic fields, only electric currents, which attracted or repelled each other. The current formed in the opposite direction to the electron's motion. He described the earth as battered by a huge plasma current from the sun, using his hands and arms, swaying on his chair and then he sat still a moment and seemed to consider what he had said and added. 'The plasma sheet doesn't actually have that many particles per inch,' he seemed amused as he spoke, 'but it is huge when you measure the whole breadth of the field.' Tom continued, telling me that solar plasma streams past the earth and enters the magnetic opening or hole on its dark side. In so doing, solar and earth magnetic fields mix and then a new field is formed. At this point, I asked whether this new field separates from the older field and whether that was 'reconnection'? He threw up his hands and said he was not an expert on this and couldn't really confirm it. Once again I envisaged the sun making love to the earth magnetically. As for 'reconnection', there seemed to be a number of different interpretations. Leaving Tom, I went on a walk on the Fire Trail to meditate on all he had said. I walked in the welcome odorous shade of tall trees, their shadows softly crisscrossing the earthen trail and swaying in the fresh breeze. I was alone again, apart from the occasional running figure panting up or down the hill, whom I guessed were scientists from SSL getting their daily exercise and nature fix.

As I set out across the University lawns for home, I heard someone calling me. Andreas Keiling, a physicist from Berlin came running up to me and breathlessly introduced himself. He had heard my talk and liked my work. He was very intrigued that an artist would come to

work at the Lab and wanted to speak with me. We spoke about the difficulty of communication across disciplines as different as art and science but that difficulty, we agreed, extended to conversations within the same discipline. Scientists, even working in the same field, found it more and more challenging to communicate with each other. I assured him it was no different for artists. I thought that perhaps an artist might actually get more from talking with a scientist than with another artist.

We met the next day and I interviewed him outside his everyday environment, sitting on a log on the Fire Trail. He was very earnest and clear, trying to answer my questions with precision and patience. His hand movements were very interesting. Like everyone I had spoken to, he used his hands to model his thoughts, to convey to me more effectively the complexity of his answers. In his case, being outdoors, the sun cast shadows of his hands across his torso accentuating their movements. Everyone seemed to speak with their hands. At first, I thought they did so to explain difficult concepts to me but then I noticed scientists in conversation at the Tuesday Teas, using their hands in the same way, much like Tibetan monks do when they debate.

Janet Luhmann didn't want to look at the camera. She wanted me to video

the digital animations on her computer and it took a lot of patience on my part before she relaxed and began speaking openly to me. When she finally spoke about her solar research, she spoke intensely and her inhibitions fell away. Her description of the churning, twisting magnetic ropes in the interior of the sun brought them to life. I commented on the breadth of her research, and she affirmed that she felt it was important to stay open and broad. Scientists, she thought, were too specialized and cloistered in their own very narrow areas of interest, which created difficulties in communication. 'When you are a scientist, you can only learn, in depth, a limited amount in the limited time we have. It's very much worth one's while to learn about the broader picture.' Talking about the sun, Janet exclaimed. 'It's all connected. The amazing thing about the physical universe is how it's all interconnected. So something that happens on the inside of the sun also probably affects us here, in some way. It blows your mind away, if you think about it, because the sun is not only putting things out but it's affecting what's coming in from the Galaxy.' She explained that the solar wind creates a protective bubble, which stretches far beyond the furthest planets and the asteroid belts.

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One Sunday evening towards the end of my stay in Berkeley, Kathelin's friend the computer guru Jaron Lanier rang and asked me out for tea and a chat. He apologized for not being in touch sooner but his companion had been unwell. 'I know it sounds ridiculous', he said as we drove around looking for something open, 'but we are thinking of reproducing.'

Jaron told me he combines a number of disciplines, unnecessarily excusing himself for seeming to be all over the place. He seemed exceptional to me. I hate the word ‘genius’. Hugely overweight, he wore his hair Rasta style, but he also seemed completely unselfconscious. When, for some reason, I mentioned hallucinogenic drugs, he assured me he had never taken any drugs. I didn’t think he would need them. He invented the term ‘virtual reality ‘ and the ‘data glove’, which is used in medical therapies. Now he lectures, does research on neuro-cognitive processes and is very involved in music, collecting and playing well over one thousand different instruments.

We spoke about time. I told him how I had discussed two-dimensional time with Jiao Maquiejo in London. Jaron said two-dimensional time was very difficult and would only work in a very small universe where there were no unexpected events, no encounters with hard surfaces, no crashes. I thought it likely that unpredictable events might have to involve more dimensions.

He asked me if I had heard the term ‘post-human’. I told him I had written about a ‘post-human’ world in *Crossing Map*. I had imagined a world in which people lost their physical presence, in which they dematerialized and became almost virtual. ‘I am not talking about the future,’ he said. ‘Technocrats, computer techies right now are predicting they will either be improving humans or replacing them. They believe we are heading for a post-human world.’ He assured me that he couldn’t bear their vision and didn’t agree with it anyway.

‘I want you to think about this question,’ he said. ‘Could the universe continue without experience or consciousness? What would happen?’

We had left the diner, where we had both had a tea, and Jaron was driving me back to Delaware Street. We discussed this as we drove around the block in his SUV. As I didn’t volunteer to answer the question, he said, comfortingly, that there were several ways to answer it. One could say that it wouldn’t matter, or that the universe would continue anyway, even if people functioned less well; more or less like robots. But you could also answer by saying that consciousness was necessary, essential, even on a cosmic level.

I liked that answer and was quite happy to leave it at that but Jaron had one more thought on the matter. He called it his most subtle answer, and it was that, in a quantum world, everything would function normally without consciousness apart from gross objects, that is atoms, molecules, planets, humans’. He left me on the corner of Delaware adding, ‘If you think about this, it may make the world a bit less bland.’

Liliane Lijn, April 2006

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