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TÍTULO: **Ray Fever to Exploding Dark Matter, Visualising the Unseen**

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RESUMEN DE LA COMUNICACIÓN

De la imprenta directa a la creación compuesta, una consideración de la visualización de los mundos invisibles de la ciencia y la diferencia en la recepción de los nuevos descubrimientos de fuerzas y dimensiones invisibles en el siglo XIX y ahora.

ABSTRACT

From direct routes of reference to creative accrual, a consideration of the changing paradigms in the visualisation of underlying or non-visible structures in science and the difference in how the discoveries of invisible forces and dimensions have been received in the 19th century and today.

PALABRAS CLAVE

Visualización, ciencia, invisible, objetividad, interpretación

KEY WORDS

Visualization, science, invisible, objectivity, interpretation

Ray Fever to Exploding Dark Matter, Visualising the Unseen

Visualising the unknown, the invisible and the infinite has intrigued artists and scientists since time began. While the ineluctable modality of the visible dominates how we conceive and transmit our understanding. Yet the non-visible worlds of particle physics, string theory and multiverses often go beyond our perceptual and conceptual capabilities, leading us into a world for which there is as yet no physical imprint. In considering the question of how to visualise the unseen or non-visible it is intriguing that while scientific evidence of invisibles forces and elements led to a fever for the invisible at the turn of the last century, recent proposals about the unseen have not provoked the same reaction. The question is whether the shift from *mechanical objectivity* to *trained judgement (*Daston & Galison, 2010), has led to an erosion of a prior trust and enthusiasm for scientific visualisations. Visualisations that now no longer capture nature's imprint, so much as trace relations and construct simulations out of accrued mathematical data.

Systems of visualization differ from society to society, with each system reflecting the concerns, interests and tastes of the society to which it pertains. In the Western world, for the public, as well as for many scientists, visualisations have provided a window on to the hidden worlds of science, from Haeckel's *Radiolaria*, to the photographs of Watson and Crick unravelling DNA with Tinker toys, or the Fate maps that reveal the underlying shape of life's replication or the Feynman diagrams that represent the interactions of particles. A dependency that at times persists beyond their proven veracity, with Feynman diagrams still being used as heuristic tools to introduce students to complex processes, to later be refuted (Elkins, 2008). From the 18th century onwards diagrams, models, photographs, recordings and more recently simulations, have been used to clarify or exemplify new developments; Bunsen & Kricho's spectrometers, Henry Rowlands' interferometers, Helhot's myograph, Mermann Minkowski's space and time diagram, and Augustin Fresnel's diffraction patterns, to name only a few. However, the "history of 20th C images in particle physics is the history of a field whose interests have moved away from what can be shown in pictures: away from resemblance and representation, and into many other kinds of images that are ultimately mathematical. The real complexity of these images is the complexity of leaving the image and finding meanings that the image can no longer

contain" (Elkins, 2008,190). The growing influence of mathematics has led to the tangible results of experiment becoming less and less visible. Observation has become almost entirely indirect: and *readings* take the place of genuine witness. The sense-data on which the propositions of modern science rest are, (Langer (1951)(Elkins (2008)), at best, little photographic spots and blurs, inky curved lines on paper or simply numbers and figures. While the data are empirical enough, they are not themselves the phenomena in question; the actual phenomena stand behind them as their supposed causes. What is directly observable is only the sign of the "physical fact" that requires interpretation to yield scientific propositions. Seeing has become a process of measuring and calculating and visualisation even for scientists a process of translating, mapping and composition.

In the 19th century a search for a scientific methodology based on experimentation led to an interest in procedural depiction, forms of visualisation that would capture nature's imprint while abnegating human prejudice. The search was to capture indexical signs, the direct physical trace of another object or event. One of the first to explore the idea of allowing nature to bear witness to its own forms, was Edward Chladni in the 18th century, however, the exponential rise of systems of procedural visualisation took place in the nineteenth and early twentieth century. Daston & Galison(2010), describe it as a shift in paradigm from *truth to nature* to *mechanical objectivity*, in which machines and photographic procedures were used to capture and reveal the invisible or hitherto unseen. The discovery of these new invisible worlds, with Roentgen's *Rays*, Thomas Edison's *Fluroscope*, C.T.R Wilson's *Cloud Chamber* or Jean Perrin's photographs, captured the imagination of the public and led to a form of "Ray fever"[1], with films, songs and popular spectacles revelling in the wonders of the hitherto unseen and the nuance of the invisible. Crookes *Spintharscope* 1903, became a popular toy with which to glimpse the trajectory of alpha particles, and film directors such as George Melies *Les Rayons X* 1898 and H.G. Well's *The Invisible Man* 1897 delved into the invisible. Science and procedural

[1] *The Roentgen Rays, The Roentgen Rays /What is this craze?/ The town's abalze/ With the new phase/Of X-Rays ways./ I'm full of daze/ Shock and amaze/ For now-a-days/ I hear they'll aze/ Thro' cloak and gown – and even stays,/These naugth,naugthy Roentgen Rays. Photography Magazine, Roentgen,*Glasser *1934 p.44*

visualisation seeped into everything from George Elliot's "Middlemarch", to Lois Fuller's "Radium Dances".

The world was seen to move and pulse with nature's invisible forces and this left an imprint on painters such as Kupka, Kandinsky and Duchamp. For Kupka a "painting is nothing other than a field of exteriorisation"[2] and Kandinsky organised his paintings according to "an exact law-abiding organization of the vital forces". Dalrymple (2005) has discussed how Duchamp's "The Large Glass", is deeply rooted in the early 20th century interest in science and the invisible, with Duchamp referring to it as his painting of frequency and box of *enregistrement*. Yet Dalrymple (2005) suggests that post 1923, Duchamp placed less emphasis on the scientific references within his work, probably because the new paradigms of relativity theory and quantum physics had supplanted the visions of mechanistic or ether physics that had dominated his earlier works. In general, perhaps because it was more readily visible, the invisible forces of science prior to Einstein and quantum physics were more comprehensible or at least more successfully transmitted to the public at large.

Physicists today proffer increasingly non-visible and at times not as yet empirically proven proposals, of worlds based on mathematical calculations, that whisper of hidden dimensions, curled up on each other, in a new mathematical sublime. Physicists propose that the universe is made of mysterious invisible material of unknown origin, that familiar elements constitute only 0.03%, dark matter 23% and that the remaining 73% of the universe is made up of dark energy, an invisible energy hidden in the vacuum of space (Kako, 2005). The question today is whether visualising the invisible opens up horizons that appeal and amaze, as did Nicolas Tesla's *Les Merveilles Electriques*, in 1895 or if the dark energies and hidden dimensions of today seem to resist capture and have a tinge of the ominous, as reflected in interpretations by Cornelia Parker such *Cold Dark Matter: An Exploded View*, 1991. Contemporary physics leaves us wrapped in a web of elegant mathematical formulae, yet with little to hold on to. A sense of the unfathomable that is

echoed in the work of Norimichi Hirakañwa, in his piece *Drift Net,* a 3D visualisation of a web crawler, where the viewer can merely contemplate a landscape of information, unable to select a link or browse the contents, left awash in patterns of data.

The scales involved in much contemporary research imply that direct registration is rarely possible, leading to visualisations becoming virtual maps that trace or photograph, constructs of data, sequencing and patterns. The computer simulations are programmed with aesthetic choices about blur, focus, smoothing or contrast. This new paradigm of visualisation of *trained judgment*, (Daston & Galison, 2010), no longer endeavours to bear witness to nature so much as create images or interpretations, that are dependent on a scientist's trained eye. A process that in some ways seems not so distant from the analogical interpretations of painters such as Terry Winters, for whom "Painting can make unconscious patterns visible" (Weinberg, 2004, 32).[3]

The images generated or simulated by scientists increasingly involve multiple pictorial systems, the visualisations being akin to virtual maps, text dependent for their interpretation. In research it is the calculations that matter not the image, which is merely a concretion, often being used for outreach, to offer a wider public an introduction. Yet speculation about the possibilities of computer visualisation have led scientists, such as Bernd Thaller to enthuse about how in the strange world of quantum mechanics the application of visualisation techniques is particularly rewarding, for it makes it possible to depict phenomena that cannot be seen by any other means (Elkins, 2008, 220). By writing mathematical algorithms with information from quantum physics, scientists such as Benoit Mandelbrot or Eric Heller have generated visualisations with computer software, with Eric Heller talking about painting with electrons, to expose the beauty and mystery of the atomic world.[4]

[4] http://www.ericjhellergallery.com/index.pl?page=aboutart (accessed Thursday12 April 2012)

Though data and calculation are intrinsic to scientific visualisations, aesthetic choices regarding geometry, viewpoint, lighting, texture, contrast and colour, form part of the programming and interpreting, blurring the frontiers between science and art. The scientist Felice Frankel outlines how to make images “more interesting”, stating that the “best” exposure depends on your taste” (Frankel, 2002). The precision that goes into her photographic procedures raising questions about what Frankel insists are still scientific images. Adaptive optics are used to subtract out distortions while other systems such as convolution, smoothing out and touching up riddle the images of astrophysics and molecular biology (Elkins, 2008).

In quantum physics, the Heisenberg principle implies that it is impossible to detach the observer from what he is observing, and it seems that this applies to visualisations today, they are made, no longer by ‘observers’ but by participators. Nano-scale investigation for example increasingly relies on devices that scan, probe and measure and the images generated with Scan Tunnelling (STM) or AFM high-resolution microscopes, are visualised but also measured and manipulated or made. Even the employment of pseudo-colour has led some such as the scientist Marie Frage to propose some kind of standardisation with a proposal based on Itten’s colour theory. While images within scientific journals, if present, are generally restricted to black and white, in the images destined for the popular press, a lush techno-colour has become the norm. The added colour, while not aiding the research that has begotten the images, clarifies but also seduces. A proposition that seems equally implicit in the generous use of terms such as beauty, elegance, and attraction employed in the language used to describe these unseen scientific worlds.

What seems clear is that artists and scientists alike render visible with analogical, scientific and interpretative methodologies, though their intentions may differ, though some scientists expound the beauty of their visualisations as new forms of abstract art. Yet “as unmediated science realism, this is abstract expressionism minus both the expressionism and the abstract, because not intentionally art, their function is the unambiguous

communication of specific information – encoded messages for a specialist cognoscenti to translate. Intellectually, we can be extremely impressed by images, which give us a greater understanding of a natural world we were never equipped to see. But although 'aesthetic' judgement may go into the selection and creation of such technological enquiry, it is painstakingly *un*invested with subjective emotion and if it gives a frisson of visual pleasure then is probably no more than the brain's reward system going into overdrive ... When we are informed as to what these weird objects actually are, they may be more likely to evoke in us a shudder of repulsion, an experience of a Burkean sublime, where our wonder is tinged with a sense of fear and a foreboding, a squeamishness at the sight of normally hidden cellular or molecular processes which connect us to fears about our own mortality, contemporary *memento mori* in other words." (Edes, 2005, 186-7)[5] While I don't share all of Ede's concerns, I am still left with the doubt of why we aren´t raving about the invisible?

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