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## *The Eye of Mars: An art-science exploration on curiosity and controversy*

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### Resumen

The Eye of Mars is a gigantic eye with a realistic aesthetic. The size of a human being, it is spherical, white and vascularized. It is connected to the surrounding world by an electrical optic nerve. It has its own behavior, similar to that of a human eye. In the darkness, the eye dilates its pupil. In the light, it retracts it. It is animated by rapid eye movements so it can scan the space around. When the eye's curiosity is shared, it unveils to the public Mars as the planet could have been in the past or might be in the future.

The Eye of Mars mixes science, technology, imagination and dream to focus on the special relationship between the Earthlings and Mars. Yesterday, we feared to be invaded by the Martians. Today, we dream to be over there. Those elements give us the desire to know, and offer us the emotional delight created by curiosity on everyone. The Eye is in fact curious and makes us curious. The Eye of Mars develops this particular relationship to curiosity, and therefore to exploration, controversy and learning. This artwork creates curiosity and gets us involved in a research exercise on curiosity.

### Palabras clave

Art-Science; Astrophysics; Interaction; Curiosity; Controversy

### Introducción

#### Mars and the eye as symbols of curiosity and controversy

##### Scientific and artistic curiosity

A subject that was continuously investigated by scientists during the last two centuries is the presence of water on Mars, our red neighbor planet. During the 19<sup>th</sup> century, Mars observers, like Angelo Secchi and Giovanni Schiaparelli, observed and described *canali* at the surface of Mars [1]. Today, the scientific community proved that liquid water has effectively flown at the surface of Mars: morphological leftovers, as dendritic valleys, paleo-lakes, deltaic deposits and alluvial cones indicate that all the required conditions were met for liquid water to be stable on the surface of Mars more than 3.5 billion years ago. However, the current hyperaridity of the planet and its low atmosphere pressure preclude the stability of liquid water on its surface.

Such an interest on these Martian events bring a lot of questions about the time and the energy spent by scientists to collect such information, but also about the joy and satisfaction it produces to draw such conclusions. One of the main answers, if any others, is the same as the one that



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motivates the artist to explore the universe from another point of view: curiosity.

Scientists and artists (and both), as sensitive and emotive beings, partly draw their lives following their emotions and temper, from which results, amongst others, this particular curiosity for their environment. As a key element for exploring, understanding and modelling the universe, curiosity can be considered as the lifeblood of both scientists and artists, waking them up in the morning and making them always go further in their research activities.

### Towards biases and controversy

Curiosity makes it possible the discovery and understanding of complex concepts from a scientific and/or an artistic point of view. However, other elements, like personal interests or confirmation biases [2], may be hidden behind everyone's curiosity. The official question, instead of being 'Is there liquid water on Mars?', may shift to "Don't we wish to discover liquid water on Mars?".

Beyond curiosity, any subject under interest often holds a lot technical, symbolic and philosophical importance for humans. In our previous example, water carves the rocks, creates oceans and rivers but also brings life, which makes difficult to consider an environment without water from an earthling's eye. Part of the bias comes when the observer automatically associates any carved or dark surface to the presence of water, or when this presence of water is associated to the existence of life, or inversely. As an example, the concept of *canali* observed by the earthling's eye of Secchi and Schiaparelli were associated to the presence of water, and even sometimes to the activities of extraterrestrial species, during more than one century [3]. Other observers however, like Eugène Antoniadi, were skeptical about these theories and proposed other points of view in which the observed structures were explained by the alignment of morphological structures and optical illusions generated through the limited quality of the observation in the 19<sup>th</sup> century [4]. These explanations are closer to what could be observed from a Martian's eye, but led to strong scientific controversies until more recent orbiter and lander probes were launched, which led to better quality

observations that closed the debate and brought solid scientific grounds.

This path through different points of views coming from different curious eyes, creating controversy and debate, is still today the way scientists work together to build new knowledge, and this is a great topic of interest in sociology of scientific knowledge [5] and in art [6]. As an example, in 2015, 'recurring slope lineae', which are dark elongated structures visible at the surface of Mars (Fig. 1), were observed to seasonally change shapes. They were originally attributed to salted water flowing at the surface of Mars [7]. Four years later, it was demonstrated that these conclusions were false and were arising from measurement errors, and these structures were finally explained by wind-driven dust movements [8]. In this situation, and as explained above, it is possible to question the role of potential confirmation biases in the scientific controversy process. Other numerous structures, that were attributed to oceans or flows of water at first glance, were finally explained by other phenomena. This is the case of 'gullies', which are not created by water but by a flowing mixture of dust and gaseous carbon dioxide resulting from the sublimation of dry ice at the surface of Mars [9].

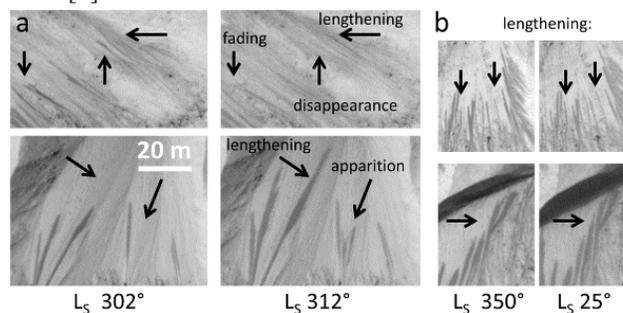


Fig. 1 Example of short-term evolutions (apparition, lengthening, fading and disappearance) of 'recurring slope lineae' at the surface of Mars.

The study, perception and interpretation of Martian phenomena is difficult because of the limited access to the planet and because of the usual long time scales along which phenomena occurred. However, thanks to the similarities between the two planets, Mars and the Earth, a better



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understanding of Mars could bring advances in a better understanding of our own planet, both from an artistic and a scientific point of view. However, to accurately understand the Red Planet, one should observe it with the eye of Mars, and put aside the assumptions of the earthling's eye to avoid biases so to enrich the controversy around the exploration and the understanding of Mars through a fresh and curious gaze. Water is only one example here, maybe the most obvious and fascinating one, but the previous analysis could be extended to a great diversity of phenomena happening on Mars, on the Earth or elsewhere. Nevertheless, the Eye, as a symbol of curiosity, and Mars, as a subject of curiosity, are well suited to such a reflection on artistic and scientific curiosity, controversy and the biases they generate.

## *The Eye of Mars*

### *Aim of The Eye of Mars*

The project *The Eye of Mars* [10] was investigated as a joint research collaboration between artists (digital artists, graphic designers, musicians, stage designers) and/or scientific researchers (physicists, mathematicians, computer scientists, human-machine interaction scientists) working together at Le sas, an art-science-society group at University Paris-Saclay (Orsay, France).

The aims of *The Eye of Mars* were to represent and question the general notion of curiosity in art and science, to investigate the concepts of controversy and bias in the understanding of new environments, and to graphically illustrate them with scientific results coming from the field of Mars astrophysics (measurements, images, simulations, theories) through a large-scale artwork interactively evolving both visually and musically with respect to the visitors' presence and actions.

*The Eye of Mars* is a gigantic eye which behaves similarly to the human eye. Curious, *The Eye* watches and follows the visitors who pass by and come closer. Engaging, *The Eye* agrees with the curiosity shown by some of the visitors and gives them to see Mars, the planet it contains, from where it is looking at us.

## Metodología

### *Technical conception of The Eye of Mars*

The structure of *The Eye of Mars* is composed of two main parts: a set of two identical acrylic hemispheres of diameter 160 cm designed for spherical video projection and a 20 cm thick equatorial separation disk comprising all the elements enabling visitor detection, tracking, behavioral analysis, video projection on the two aforementioned hemispheres, directional sound production, cooling and hanging (Fig. 2). All these interactive visual and sound systems are connected together and remotely controlled through a computer located away from *The Eye*.



Fig. 2 *The Eye of Mars* with the South hemisphere being removed for technical setting before the exhibition *Les Yeux grand ouverts*. ©2016 Matthieu Courgeon

Visitor detection is performed thanks to 16 infrared video-cameras located at the periphery of the equatorial disk and screening the 360° environment around the artwork. The images captured by those cameras are then 'stitched', or combined into one 'panoramic' image, which is analyzed in real-time to detect every individual visitor, analyze and characterize their position and behavior, and generate signals that are exploited for video and music generation.

Video projection is ensured by two independent projection systems: one for the 'North' hemisphere and the other for the 'South' one (Fig. 3). The technical disk mentioned above connects the two hemispherical images. Along the light-



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path, each projection system is composed of a long focus video-projector fixed horizontally on an equatorial metallic plate located inside the technical disk, two optical lenses that aim at focusing the image produced by the video-projector on a small area (1-2 cm in diameter) where an oblique mirror directs the projection either upward or downward, and a very short focus (quasi-hemispherical) optical lens to project the image on an even smaller surface (1-2 mm in diameter) where a 'fisheye' lens is set to project the image over the whole hemisphere.

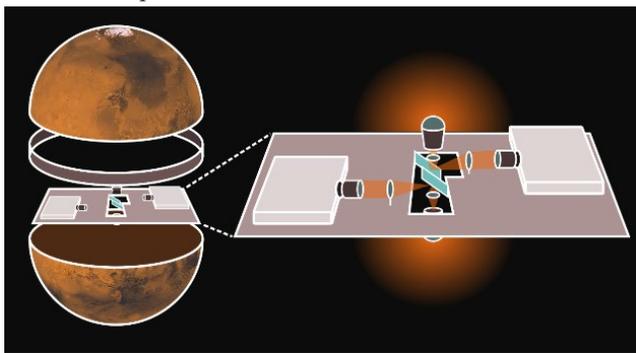


Fig. 3 Schematic representation of the technical structure of *The Eye of Mars*. The two projection hemispheres are represented with, between them, the equatorial technical disk. A particular focus is given to the optical system enabling the simultaneous video projection on the two hemispheres.

Directional audio production is ensured by 8 loudspeakers located inside the separation disk and able to generate sound independently and directionally everywhere around the artwork. To do so, these loudspeakers are driven through 8 independent audio channels linked to a unique sound card located inside the equatorial disk. As all these video and audio systems notably increase the temperature inside the closed sphere, a ventilation system made up of 8 flow-in and 8 flow-out double fans was implemented to ensure air-cooling of the sphere. Finally, the equatorial disk was reinforced to remain mechanically stable despite the total weight of the system (around 100 kg) and four metallic rings

were fixed on the separation disk to hang the artwork with four steel lines.

### Behavioral approach of *The Eye and Mars*

All audio and visual contents of *The Eye of Mars* were created specifically for this art-science work.

Visual contents comprise two categories: *Eye* and *Mars*. For the first one (*Eye*, Fig. 4), a complete human eye is displayed on the projection sphere with many realistic details: iris, pupil, and vasculature. The image of the eye is generated in real-time, which gives the possibility to mimic controlled and spontaneous eye motions, physiological diameter changes of the pupil and iris color tuning. Furthermore, to better render the eye's moisture, real-time images of the visitors and their surrounding environment, captured by the 16-camera set, are displayed as if the visitors could see their mirror reflections in the eye. For the second one (*Mars*, Fig. 5), real images of the Martian surface are displayed as if the entire Red Planet was standing in front of the visitors. On these images, visitors can discover common large-scale elements usually observed on Mars: craters, valleys, volcanoes, poles covered with ice. Moreover, graphical elements were computationally simulated onto these images to illustrate events that were either actually observed at the surface of Mars or deduced from contemporary morphological leftovers. All the elements mentioned above, like past liquid water flows, 'gullies' and 'recurring slope lineae', are simulated and displayed. Moreover, other events like meteorite impacts, past volcano eruptions, dust storms, polar ice melting and geysers, as observed very recently by the scientific community, were simulated as if they were occurring in front of the visitors. For visual quality reasons, realistic space and time scales were not respected in these representations.



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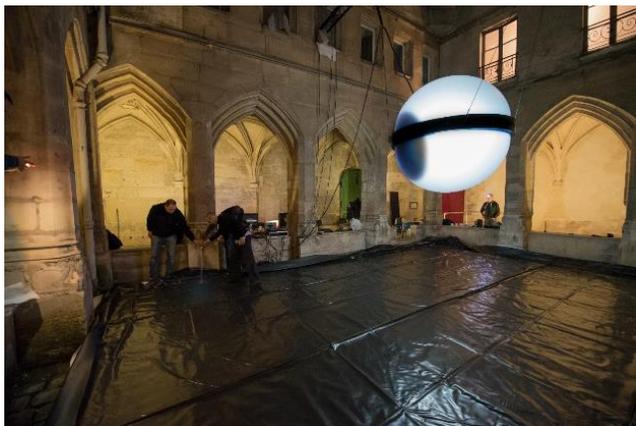


Fig. 4 Picture of *The Eye* staring at Xavier Maître and Julien Kozłowski during the filling of the water mirror, before the exhibition *Les Yeux grand ouverts*.

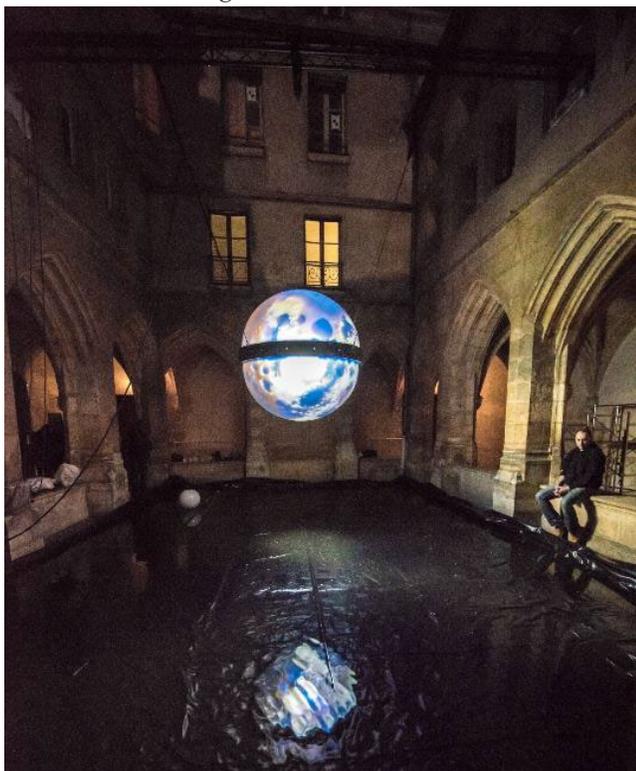


Fig. 5 Picture of *The Eye of Mars* showing the Red Planet with oceans, as it may have looked like several billion years ago.

Audio content englobes calm background ambiance music composed of steel guitar melodies and synthetic tracks, but also percussive elements, like water drop sounds, drum shots, noises made by flowing liquids and other audio elements evocating the physiological moisture of the curious eye and the different events that can occur at the surface of Mars.

All the visual and musical elements and events mentioned above were linked to the signals produced by the visitor tracking and motion analysis system so as to make the artwork interactive and behavioral. Therefore, when the visitor arrives in front of the system, the *Eye* starts tracking him or her, and it stares at him or her as the visitor moves around the artwork. If a second visitor comes, the *Eye* shares its attention to the two visitors by looking at the first one and then the second one. However, more attention can be given to curious behaviors, as arm motions or jumps for example. If a visitor comes even closer to the system, the *Eye* focusses at him or her, adapting the size of the pupil to the ambient light intensity. As an interaction is created, as the earthling visitor shows curiosity for this Martian eye, the *Eye* shows back curiosity to the visitor but with its own glaze, with the eye of Mars, and offers to the visitor images and events from where it comes from: Martian meteorite impacts, dust storms, or water flows may appear depending on the visitors' behaviors. These events pave the way to an intimate interaction between the visitor and the artwork, opening the door to emotions, but may also start discussions and debates between visitors, source of scientific controversy and artistic exchange. Once the discussion is closed, the visitors leave, the artwork blinks to an eye again, looking for someone else and curious to see and hear a new controversy about where it comes from.

## Discusión o resultados

### A probe for emotions and a medium for Martian controversies

*The Eye of Mars* was exhibited several times during the last five years, mainly in France. Every exhibition was a special opportunity to observe and study the great diversity of



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visitors' reactions and behaviors in front of the artwork and the resulting interactions between the earthlings and *The Eye of Mars*.

The first exhibitions were held at Le sas>105, which is one of our design, making and exhibition place at University Paris-Saclay (Fig. 6). During formal exhibitions or more informal meetings and discussions, *The Eye of Mars* was presented to university students, researchers, administration staff and occasional visitors from outside the University. *The Eye of Mars* was often exhibited with other artworks from Le sas, like *Primary Intimacy of being* [11] and *Into two* [12], which express the discovery of a new kind of intimacy through diverse medical imaging modalities, or *Worlds you go through* [13], an interactive and immersive artwork questioning curiosity, perception and social interactions through the prism of astrophysics and general relativity. During every exhibition, *The Eye of Mars* opened questions on Mars astrophysics and controversies, on curiosity and on the technical conception of the system. Often, *The Eye of Mars* triggered deep emotions from the fear to be stared at and tracked by such a gigantic eye to the wonder to stand in front of a realistic representation of a planet located several tens of millions of kilometers away from Earth.



Fig. 6 *The Eye of Mars* exhibited at Le sas>105. ©2018 Christophe Peus.

Another exhibition was held all night long on October 7<sup>th</sup>, 2017 in *Les Yeux grand ouverts* (*Eyes wide open*) as part of the contemporary art festival *La Nuit Blanche* organized in Paris, France (Fig. 7). This exhibition was held at the Cloître des Billettes, a 15<sup>th</sup> century cloister and the only remaining one from the Middle Ages in Paris. During this night, *The Eye of Mars* was exhibited together with *Les Yeux d'Argus*, the large glass ocular globes created by the Dutch glass artist Vincent Breed. During the entire night, about 10,000 visitors wandered through the cloister to observe *The Eye of Mars* and *Les Yeux d'Argus*. Some people walked in just 30 s through the ambulatory of the cloister, just the time to have a look. Other visitors took the time to observe the Eye and Mars, and experiment the interactivity with the artwork. Finally, some people remained tens of minutes and sit in front of the gigantic globe, sometimes losing themselves in its reflection given by the water mirror installed behind, or lying down on the old low stone walls surrounding the ambulatory to relax, lulled by the water drop sounds generated by *The Eye*.

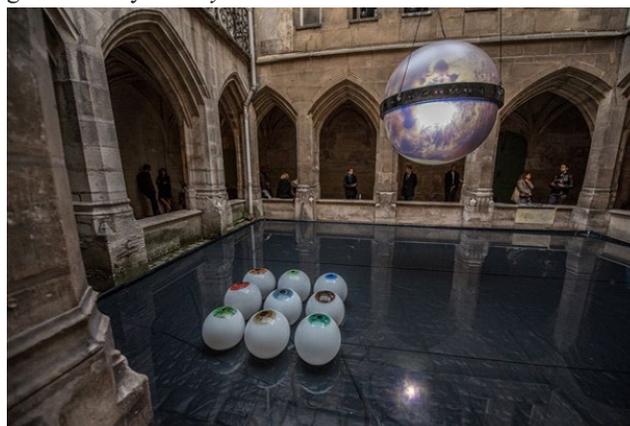


Fig. 7 *The Eye of Mars* exhibited during *Les Yeux grand ouverts*. ©2016 Matthieu Courgeon

*The Eye of Mars* was also exhibited during the event *StartUp for Kids* organized between May, 26<sup>th</sup> and 28<sup>th</sup>, 2018 at the French engineering school CentraleSupélec (Gif-sur-Yvette, France). During these three days, 4,000 children and their parents were able to exchange, discover, and



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experiment about innovation during conferences, coding workshops and demonstrations made by tech companies. As an example of what can be made at the limits of art, science, and technology, *The Eye of Mars* was standing in front of them inside a dark box designed to better observe the detailed projections of *The Eye* and *Mars* (Fig. 8). Beyond the scientific mediation work and more informal discussions around the artwork, the questions of curiosity and Mars astrophysics, the kids were impressed by this eye tracking them inside the room, sometimes considering it as a game. Others preferred to lie down below the artwork to better contemplate the south pole of Mars. Often, children curiosity was triggered by crater impacts, dust flows and geyser appearances on the globe, which opened discussions and explanations on what happens today at the surface of the Red Planet and what it was looking like several billion years ago.

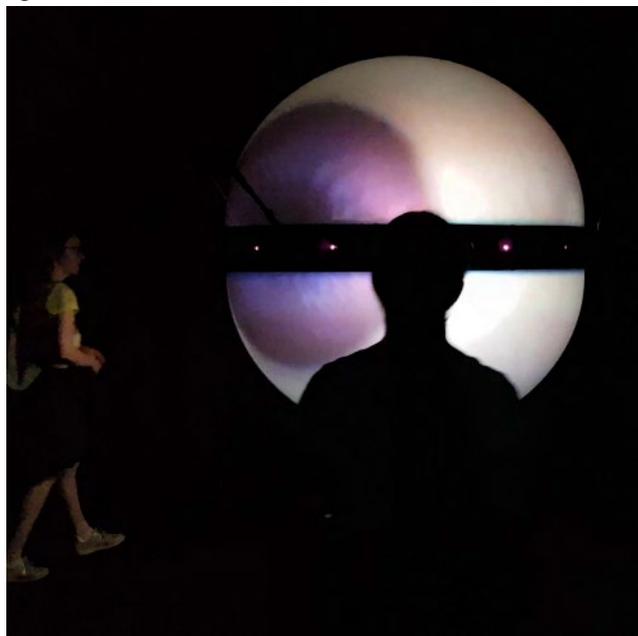


Fig. 8 *The Eye of Mars* exhibited during *StartUp for Kids*.

## Conclusiones

We now look ahead to include *The Eye of Mars* in a behavioral study to experiment the effects of human-

machine interactions in visitors' reactions and displacements, as recently carried around the artwork *See me through you* [14]. With visitors' consent, the path they will follow around the artwork, their face expressions and their body gestures will be recorded while meeting with *The Eye* to the last discoveries they would make at the surface of Mars. *The Eye of Mars* is an open field for simultaneous scientific and artistic exchanges and mediation. In the visitor's course, diverse topics ranging from the key role of curiosity in art and science to the last scientific discoveries made in astrophysics are addressed. Enabled with an impressive simplicity, it fosters serendipity along the strong emotional and curiosity triggering effects of *The Eye of Mars*.

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