

ORIGINAL ARTICLE

# Languages of Visual Arts: from Venetian Bas-reliefs to Nucleosynthesis, Pulsars, and Beyond

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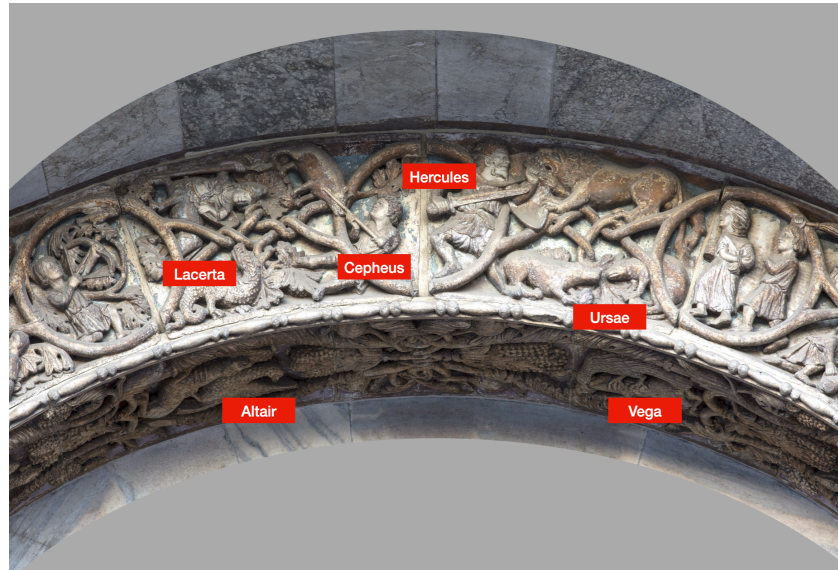
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**Abstract:** Can researchers use honest, beautiful, and accurate visual strategies to communicate something that is not visible? Especially with phenomena that are just theoretical concepts, or that are too small or too distant in time or space. Art related to science can be much more than divulgation (in the sense of conveying “second-hand”, or “cold”, research content). Art can bring the general public straight into the core of state-of-the-art research; in some respects, art can become first-hand research in itself (but, at the same time, verge on the edge of fiction), when striving to convey something that science is still trying to define, or to evoke things from an almost obliterated past. We present here some considerations on the above themes, from two different points of view: by an art-historical researcher and art curator, and by an artist active in science communication. In the first part of this article, Gloria Vallese describes the experience of two art and science exhibitions organized by the Accademia di Belle Arti in Venice, Italy. One of the artworks featured was by Alessia Lorenzi, the other author of this article; her experience in that context, together with other considerations from inside her current scientific visualization practice, is analyzed in the second part of this text. The second part of this article will cover some critical points and strengths of visual communication in science applied to the invisible. Practical examples and solutions will be provided to address the critical points and to reflect on opportunities and responsibilities in these fields.

**Keywords:** Edutainment, science communication, Venice St. Mark’s Basilica main portal, public engagement, anima-tion, astronomical knowledge in 13th-century Venice, imagery in nuclear physics, immersive experiences, outreach

## 1. Introduction (GV)

Stars and Travels (2016 and 2021) was an art and science exhibition in two parts, ideated by Alessia Lorenzi (second author of this text), and entirely created by professors and students of the Accademia di Belle Arti di Venezia.



**Figure 1.** Venice, St. Mark's Basilica, main portal, detail of the lesser archivolt: some of the stars and constellations first observed in 2014. The original polychrome and metallic applications are lost. HD photo composition by students Riccardo Bortolotti and Stefano Leoni for the exhibition *Stars and Travels*, 2016.

It stemmed from the discovery that the sculpted archivolts of the main portal of St. Mark's Basilica in Venice (half of the 13th century), that for a long time were believed to be merely ornamental, contain an early, extraordinary sculptural representation of the celestial sphere: they depict stars and constellations, disposed not randomly, but as to compose a sol-lunar calendar. (Vallese 2014; 2015; 2017). Stars and constellations are represented not only according to the Western iconography, but to a vast range of visual languages from Northern Europe to India and China: this in connection with long-distance travels, which were the basis of the Venetian mercantile social system in that age.

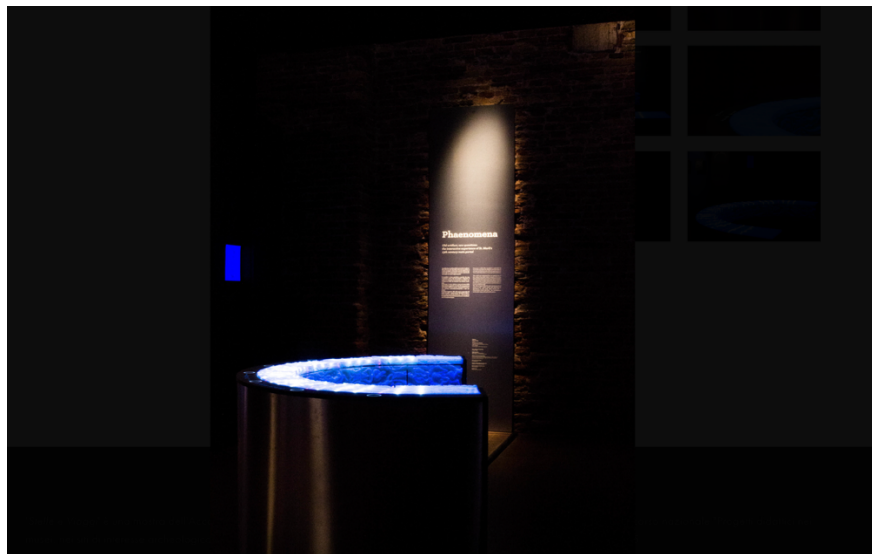


**Figure 2.** *Stars and Travels*, 2016 at the Magazzino del Sale 3, exhibition venue of the Accademia di Belle Arti di Venezia. Photo: Shovupa Ainur Rahman, 2016.

The main portal of St. Mark's is daily under the eye of the Venetians and of thousands of visitors from all over the world, yet it had never been actually 'seen', because, in its present condition, it cannot be: the original polychromies which once covered the bas-reliefs, helping the observer to distinguish the figures and their interactions from several meters below, has now gone, exposing the uniform yellow-grey of the underlying marble (Lazzarini 1995; Piana 1995). Consequently, the human and animal interactions represented high on the portal archivolt have become hardly readable from ground level. The first objective of the Stars and Travels exhibition project, therefore, was to bring the bas-reliefs at the level of the visitors' eye and to make them 'visible' again, in various ways. The first step was a series of high-definition photographs expressly taken by an équipe of students and professors of the Accademia di Belle Arti di Venezia, which organized the exhibition, and hosted it in its institutional venue, the Magazzino del Sale 3. Each portion of the bas-relief could be observed for the first time in close-up and at length; the panels with the enlarged HD photos were accompanied by illustrations from ancient manuscripts, celestial maps, photographs of the night sky, everything that made the stars and constellations recognizable in the tiny, bizarre figures of the bas-reliefs. The walls of the venue were painted in dark blue, and the light modulated as to evoke the ambience of the night and of the starry sky, to keep this idea constantly in the background. As the title Stars and Travels suggests, in the 13th century the travellers practiced celestial navigation, i.e., oriented themselves by the stars; the deep astronomical knowledge exhibited by St. Mark's portal was directly connected with the long-distance commercial travels which were at the basis of the Venetian economy and politics in that age. Moreover, along the route of the visitor were placed original works of art, created by the students of the Accademia di Belle Arti di Venezia, with the intent of suggesting vividly, and with great and immediate sensorial impact, some of the most complex ideas underlying the research.

## 2. Art and ongoing research: a frontier (GV)

Not many theoretical discussions about art installations for new museum narratives were available in 2016, at the time of the *first Stars and Travels* exhibition, except for the groundbreaking activity of the Studio Azzurro group (Studio Azzurro 2011; 2016).



**Figure 3.** Shovupa Ainur Rahman and John Volpato, *Phainomena*, interactive installation, 2016. Photo: Shovupa Ainur Rahman.

In the last decade, the experiences involving art in museum narratives have quickly multiplied; and so have the analyses, the comparisons, the critical evaluations (Mandarano, 2019).

The consensus is now that for the general public the approach to scientific content through art is not, and cannot be, as minute and detailed as through the reading of a technical text. What art can do is rather to ignite interest and involvement, moving the public to further spontaneous exploration. This, in turn, increases general awareness, which can make a crucial difference, not least in terms of political choices and financial decisions.

On the other hand, art can go beyond the simple divulgation, meant as the sharing of already assessed contents. It can bring the general public straight in the middle of very new paths of investigation. Yet, this poses some problems. To share with the general public ongoing research, means to share results that are still partial, hypothetical, and/or not yet completely verified. Is this advisable? Is it ethically correct? The answer is very much a matter of choice. As an art-historical researcher and an art curator, I am for bringing the general public, as far as possible, where the research is still ongoing. This, because the alternative does not appear very safe either. Should we wait, for example, that the debate on global warming is settled, to involve the public?

And then, there is another task that the artist can do in connection with science: with his visualizations, he can manipulate already known symbols in an original way, to anticipate the scientist's vision, to push his effort for a mental synthesis one step forward. Chris Impey describes vividly the interaction between art, science, and science fiction, in his history of the notion of 'black hole' (Impey 2023).

### **3. Viaggi riflessi (2021), installation by Alessia Lorenzi (GV)**

At the time of the second *Stars and Travels* exhibition (2021), our ongoing art-historical investigation had evidenced that originally the bas-reliefs of St. Mark's portal were not only clad in polychromies but had also metallic asterisks of different sizes applied to the stone, to highlight the stars and constellations. These metallic applications are no longer present, as the surface has been eroded over the centuries by exposure to atmospheric phenomena. Yet, where they once stood, tiny regular patterns of holes on the stone are still visible. Hi-res photographs treated with experimental software, such as D-Stretch, can bring these tiny holes back into clear visibility (Vallese, Campanile, 2021). Every day, at dusk, there was a moment in which the stone carvings became invisible in the increasing darkness, but the metallic applications would have glistened a little longer, evidencing the outline of the constellations; at dawn, the effect would repeat in reverse.



**Figure 4.** Alessia Lorenzi, *Viaggi Riflessi*, installation for the exhibition *Stars and Travels 2021*. Own Work. Photo: by the author.

In her installation *Viaggi riflessi*, Lorenzi created a holographic box with an animation movie, in which the public actually could see the bas-reliefs fading into dark, leaving place to the shining outlines of the constellations, and vice versa (Lorenzi, 2021).

Thanks to this artwork, what would have been only a description on a written page became alive and present for the exhibition visitors, impacting them in a deeply different way. The ancient glimmer on St. Mark's facade was revived in a vivid sensorial experience, which caught also its delicate, transient nature: the visitor was invited to 'touch' the light effect, inserting their hand in the opening of the holobox, thus experiencing (literally, 'grasping'), the immateriality of the figures drawn by the quickly fading ray light.

It is important to note, however, that the maps of the stars once present on the bas-reliefs were at the time (and still are) under construction; their completion will probably take many more years from now. The star maps used for Lorenzi's holograms were preliminary, which means they could prove incomplete or even incorrect in some details in the future. Does this make our operation wrong, deceptive, or ethically incorrect? Again, personally, I think not. At that time (2021), we chose the option to share with the general public the basic idea, i.e., the rediscovery of the metallic outlines of the constellations on the bas-reliefs, rather than to wait many more years for an accurate and detailed reconstruction of the star maps.

The experience of *Viaggi riflessi* within the *Stars and Travels 2021* exhibition was a step on the path that Lorenzi is now pursuing, in a most interesting and crucial field, art applied to the representation of something that is not visible: either because science is still trying to grasp it, or because it can be represented only in symbolical way, since, being infinitesimally little, it is not, and never will be, accessible to the human eye.



**Figure 5.** Viaggi riflessi: two stills from the holographic video. Own work. Photo: by the author.

#### 4. Visual communication and data storytelling in science (AL)

There are many ways of transposing science into a visual message. The point of departure could just be a huge amount of raw data stored in a common csv or excel file. Experts and researchers might understand a sequence of recorded data, but in most cases, this is not enough to communicate hypotheses and to read the results in a clear and effective way.

Researchers in nuclear physics use graphs to read data; this method allows them to see beyond the visible. The fact that researchers themselves need specific visualization methods to be able to read what they are doing highlights how much visual communication and its architecture are of the essence in this field. There are many different types of charts: bar chart, line graph, tree map chart, scatter plot, waterfall chart, bubble chart, field line diagrams, and others. A specific graphical representation can influence the reading of the data, and this means that it can also influence how researchers think about the phenomenon investigated by themselves. A graph imposes a specific point of view of the phenomenon and also requires the ability to compare certain values represented in the chart (Padilla, Creem Regehr, Hegarty et al., 2018).

The communication possibilities expand incredibly when, from the internal communication and data visualization methods used during research, we move on to external communication, to public engagement (Pitrelli, 2003). The general public may not be familiar with the above-mentioned visual ways of reading data. Some graphs, certainly effective in the world of research, are difficult to understand in other contexts.

For these reasons, to explain scientific data to the general public, science communicators use other types of languages derived from common symbolic systems, including the use of metaphors recalling familiar concepts.

This is very evident when talking to a general audience: spoken language has a great influence in the way in which we read reality, but visual language can reach both the researchers and the general public (Lupi, 2017).

There are many cases of the influence on reality through language: reading errors, interpretation errors, and a wide variety of biases related to perception (for example cognitive biases about the comparison of values,

but also psychological and social biases like the linguistic intergroup bias). An in-depth knowledge of perception processes can help communicators in designing more effective tools and communication strategies.

Concerning internal communication within the research groups, there are conventions established in the academic environment. Learning to read and use a certain type of graph can require study, so it is realistic to think that most of these charts are not suitable for the general public.

There are cognitive studies regarding the ease of reading certain graphs rather than others (Vandemeulebroecke, Baillie, Margolskee et al., 2019; Cleveland, McGill, 1948). Concerning the general public, the visual possibilities are much wider, even if new challenges arise correlated to the need to balance between over-simplification and the accuracy of complex information. Rather than using specific high-accuracy data tables and graphs, researchers can use intuitive pictures and symbols inserted inside the graphs (an example: the bars of a chart-bar could be replaced with stacks of coins to indicate investments over the years. This solution could be quite intuitive and attractive, and suitable for social media, both as motion graphics animations, and as a static image). Such graphs, however, can be so inaccurate that they could be considered rather as mere illustrations inspired by the original graph. Their purpose, on the other hand, is not to present the entire data set, but rather to suggest what the researchers want to communicate.

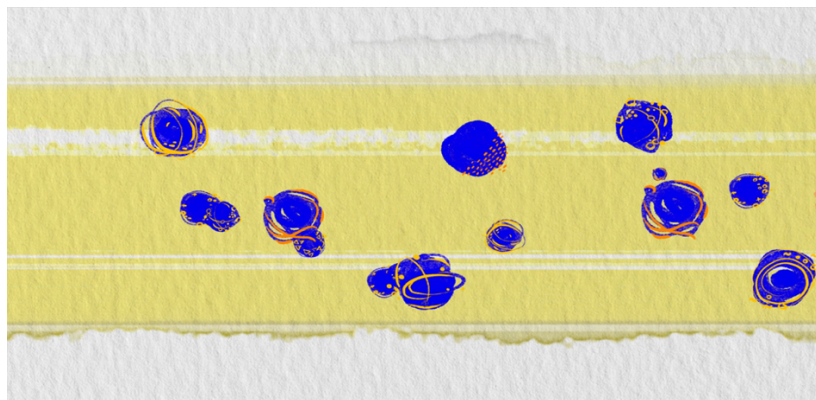
Data storytelling may be meant to tell or represent a phenomenon with data, or just starting from data (Manovich, 2002). A data storyteller must make decisions to design solutions that are creative but also useful for the purpose: if the purpose is to accurately present a set of data, the creative solution will probably be a more complex and more conventional communication system; otherwise, the risk is to fall into oversimplification or to increase the probability of interpretation errors. Sacrificing accuracy for engagement is as risky as producing content that is rich in technical content, but too complex or boring to be understood and consequently remembered. Too difficult descriptions can push people away and not be listened to; on the other hand, simplistic descriptions can even undermine credibility. Trust in science and institutions is also influenced by how the information that they produce is presented (Gregory, Miller, 1998). Despite it all, memorable experiences and engaging explanations are not necessarily condemned to oversimplification and unreliability; finding the balance for the right target in the right context appears to be the core of the challenge for scientific communicators.

To sum up, there can be different types of data representation: data tables, exact scientific graphs, accurate graphs with a simple visual language, data storytelling, and art in its various forms (which can become completely new artworks inspired by the original data, and by the considerations that can be drawn from that data) (Mancuso, 2020). It is important to clarify to the public that inaccurate kinds of engaging content cannot replace the original data, because the information could be oversimplified. Clarity and honesty not only determine credibility but also the effectiveness of communication projects, by reducing the effect of cognitive biases.

## **5. Engagement, accuracy, misleading communications (AL)**

The style chosen for a communication project can make concepts appear more complicated (or simpler) than they actually are. Communicators can decide whether to create accurate or approximate content based on their purpose (it usually depends on the context and on

the target audience). There are delicate balances between accuracy and approximation (in favour of engagement) that cannot coexist in the same project; therefore it is necessary to discard one maintaining honesty and allow the other to find a dedicated space in another place (for example a QR code with the sources, explanations and insights or a volunteer present during an event to answer questions). A well-known example of a balance difficult to find is the representation of the Solar System: very often, even in books used in schools, the planets are represented with the wrong scale and wrong distances (Masters, Park Rogers, Vanashri, 2011): this because the illustrations would result ugly, with the planets appearing just like tiny dots very distant from each other (the mass of the Sun is the 99.9% of the mass of the Solar System, the Earth is only about 0.1% of the mass that is left). There are scientifically correct methods, such as the use of a logarithmic scale to represent the planets with an aesthetically good aspect yet maintaining the correct scale and distance; but this mathematical method can cause many errors of perception. The logarithmic scale is not intuitive for us humans; in this way, the students would remember the planets as much bigger and much closer than they actually are (even inserting a ruler into your drawing or animation, to make the use of the logarithmic scale evident). In this case, an appropriate solution could be to place a pleasurable image on a logarithmic scale next to an image in the real scale (with distant tiny planets instead of huge ones). This is an example of how a problem can hide its solution inside: this honest and clear solution would produce amazement, which in turn would help to memorize the concept. The problem of representing quantities of this scale (astronomical distances and sizes), is also typical of nuclear physics and quantum science. Atom pictures can also cause several misunderstandings (Kaya, 2023); one of these concerns the atomic void (which is considered by many chemists to be a kind of hoax). In numerous science communication contents, atoms appear “empty”, due to how they are represented (the volume of the atomic nucleus is only 0.01% of the atom). The question becomes quite complicated if we think about the laws of quantum mechanics and the dual nature of particles: it appears very difficult to identify a single way of representing all these concepts in a simple and engaging way. Even just talking about volume: the volume of the atomic nucleus is the region of space where all the nuclear charge and neutrons are substantially enclosed, the electron cloud is the region of space where there is a high probability of finding electrons. “Volume” can concern different things (specific physical properties and probabilities); but actually we are talking here about regions of space. The scheme of an atom, even if it may seem so usual and easy, is a very difficult thing to design without oversimplifications (Türk, Nur Tüzün, 2018; Albanese, Vicentini, 1997).



**Figure 6.** INFN-LNL Introductory Video, 2023. Still from the video. Own work.

There are many images (whether photographs, or graphical interpretations of data) that come directly from scientific instruments; and yet, although they may be considered real, and so rich in detail that they can be studied to discover new physical laws, they can generate misunderstandings. It is not enough to see something “real” to read it correctly (in this article there will be an example about photos of atoms and common misconceptions about atomic structure).

Although even “real” images can lead to misunderstandings, it may be urgent and necessary today, in the information age (or in the generative age), to teach how to distinguish between photos, simulation, interpretation and artwork inspired by a scientific concept (for science engagement purposes, or science fiction). This urgency arises from the fact that all these areas and contents, different from each other, share the same visual languages and can be mistakenly exchanged, causing problems in trust, and misunderstandings (completely different things that speak the same language, blurring the boundaries of contexts). It is also useful to learn about cognitive biases and to develop good digital literacy, in this way it is easier to avoid the spread of fake news, and to reduce information pollution. Communicators can play an important role in teaching this, by highlighting what they mean by clarity and honesty when designing scientific content for the public (Orecchia, Preatoni, 2022).

Generative AI will produce further pollution. Not only this becomes a problem when searching for information a polluted web; it will also become a problem for the generators themselves, as a sort of death spiral that causes the generation of nonsensical AI contents. Communicators could make a difference, by raising public awareness on this topic, and by teaching how to recognize the reliable sources. The public should get used to scrutinize their sources, to be informed about the type of content they are seeing.

At the beginning of the generative era, since generators have become so popular and so easy to use, the generated images can represent our common idea of a certain topic (but only if the dataset used for the training has been sufficiently large and varied). To visualize the common visual idea that people have about atoms, black holes and dinosaurs, a researcher could simply ask some AI to generate images of them. The result might seem very familiar to most people, nevertheless those images derive mostly from fictional images, from art and simulations. The web is so full of images of black holes and dinosaurs that even an image generator could create new ones, and they would be recognizable as such, even if no one saw them in real life. AI will only reinforce these visual images of invisible things, but it can do so because these images were already common in our imagination. The fact that people believe them to be true, may indicate a failure of science communicators to clarify how and why these pictures were made. A common example is the use of the term “photo” for scientific images that are not actually photos. Researchers and communicators should clarify these terms or use different terms because they convey important concepts about the identity of the content. The term “photo”, like the term “simulation”, can generate presumptions, and it should be accompanied by a certain explanation. Researchers have been using certain images of dinosaurs for so long that it would be difficult to imagine them being different. Movies have certainly contributed extensively to the creation of the collective imaginary about them, but these images have long been confirmed by scientific communication projects. The language of cinema and the language of science can collaborate by exchanging suggestions and images, the important thing is to help to keep truth separate from imagination. Just as a dinosaur can ‘seem’ real, an effect of general relativity in the distortion of

space-time can seem like cinematic absurdity, conveying distrust to the scientific world that supports it. It's not the job of science fiction to explain science accurately. Like other film genres, science fiction movies can take advantage of technologies to make their footage realistic or even hyper realistic. These seductive images will certainly continue to compete with images that come from the scientific world (it means that imagination and fake news may seem more interesting than real images and, in a certain sense, more worthy of attention from a general public); yet, it would be simplistic to think of limiting art and creativity, in the field of science communication, imposing a range of homogeneous styles reserved for scientific communication (in order to visually distinguish scientific content from one that is the product of the imagination).

Real science pictures are usually rich in information. Artistic interpretations may visually convey ideas and make us feel something, but we can't discover and measure reality based on them in a scientific and objective way.

We could say that artistic interpretations are "empty" due to the lack of information about reality (but we can conventionally say this only from this perspective and for this specific purpose, without underestimating the epistemology related to art and philosophy).

A simple way to explain the difference between an image from the scientific world and a fictional artwork based on the same topic could be spectroscopy.

Spectroscopy allows scientists to analyse "light", unveiling valuable information about the composition, the temperature, the velocity of celestial bodies, and the identity of particular atomic nuclei.

Redshift and Blueshift are very well-known examples from astrophysics (the increase or decrease in the frequency of electromagnetic radiation). This data about the frequency and energy of photons, visible using scientific equipment, can indicate to astronomers that a star is moving away (it appears red because its light is shifting to lower frequencies on the colour spectrum), or approaching (tends to blue). This effect is also called the Doppler Effect (Schilling, 2023), which is what we experience when an ambulance passes near us, and the sound perceived during its approach is different than when it is moving away). Colour, in this case, has nothing to do with style, with a personal subjective choice dictated by taste or emotion; it is the necessary result of a process, and allows researchers to read reality objectively.

The second example concerns nuclear physics applied to cultural heritage: it is possible to visually distinguish different materials by reading the light via spectroscopy; in this way, it is also possible to carry out dating and discover any false findings (Lo Giudice, Re, Angelici et al., 2017).

These data and the types of images we produce through them allow us to delve into physical phenomena with scientific rigor. This is not valid for artistic interpretations and for excessive simplifications.

It is important to note that an accurate simulation and an artistic work can appear similar to reality, indeed, sometimes they can seem more real than the original data that was collected in the lab, as often happens with images of celestial bodies and of extreme physical phenomena. It's a difficult competition to win on the aesthetic level: images of a truly scientific nature are not created to entertain. It is now known that the idea of realism is a convention and the culture we have regarding these areas can be refined, allowing more effective cognitive distinctions regarding the meaning and the nature of what is observed (Bate, 2017).

To facilitate the distinction between different types of visual solutions, a research organisation could use this distinction as a standard for their communication projects: original data usable for research purposes, accurate simulations intended as predictions based on theories, content designed to communicate something, and artistic interpretations.

In this four-level simplification, the original data could consist of raw data, tables, graphs, if it is accurate enough to be usable to discover or understand something with scientific rigor. Contents designed as a product created with the aim of explaining something in a certain way can hide many risks, so it is good to specify what it is and how it was done. For example, a project could be oversimplified and therefore could require support material for in-depth analysis, this type of material can be exploited for unpredictable purposes, such as the generation of plausible fake news through decontextualization, thanks to the interpretability levels. On the other hand, works of art can be completely free from the purposes and responsibilities of the communicators, just promoting interest and involvement.

## **6. Case studies: Visual solutions to show the invisible. (AL)**

New Media Art, interactive installations, and science documentaries can effectively bridge the gap between technical information and captivating communication designed for the general public.

One of the key principles in creating these visual solutions is striving for a balanced subtlety between accuracy and engagement. As mentioned earlier, trading off accuracy for engagement or vice versa has risks built into it, in this case perhaps resulting in oversimplification, or in lack of comprehension and remembrance. Thus, communicators are tasked with making deliberate creative choices, often with the use of symbolic systems and metaphors referring to known notions, thus however holding true to scientific intent. In an age of information overload, and of artificial intelligence capable of generating both images and texts, it is essential that these technologies also encourage truthfulness and clarity. What this means is making it clear to the public how to distinguish among photographs, simulations, interpretations, and works of art based on scientific phenomena, thus encouraging digital literacy as well as preventing disinformation. This openness and transparency might be necessary in building trust in science and its institutions in this society of information (increasingly characterized by digital information pollution).

These following case studies –*Nucleosynthesis VR Experience*, *Pulsars, A Tale of Cosmic Clocks*, *INFN-LNL Introductory Video*, and *Viaggi Riflessi* – are practical demonstrations of the different visual styles in use. All the projects demonstrate creative ways of rendering the invisible visible, presenting difficult-to-understand scientific substance in a form that is both accessible and engaging, and gets to work on the precarious balance between scientific accuracy and artistic freedom.

*Nucleosynthesis VR Experience* is an interactive VR project which has been used for several years by the Legnaro National Laboratory of the National Institute of Nuclear Physics (INFN-LNL). The user, taking on the role of a researcher, embarks on a fantastic and metaphorical journey in a virtual world (literally virtual and fantastic: there is a “virtualization” of the user at the starting scene and teleportation between various scenarios). In this fantastical voyage, users encounter reconstructions of real concepts, places, and experimental tools installed at INFN-LNL. It is an example of artistic and extreme blend of reality, fiction, and wonder. It is so extreme,

metaphorical and science-fiction-like that it declares itself to be a world of false engaging images blended with the truth. The purpose of this experience is to allow general users to familiarize with the topics of particle astrophysics and nuclear physics by acting on people's intrinsic motivations.

Thanks to intrinsic motivation, a student can be much more inclined to search for more information, to ask questions, and to remember concepts linked to exciting memories (Csikszentmihalyi, 2014). This Virtual Reality experience can be enjoyed during local outreach events where a researcher can answer visitors' questions or encourage them to reflect on what they have seen.

To carry out this project, a lot of User Experience Design and User Interface Design work was done to make the experience comfortable and prevent episodes of motion sickness. Furthermore, careful planning was made for the symbolic systems and to choose the style used in this project.

The main scene consists of a nuclear physics experiment. In the daily life of nuclear physics laboratories these phenomena are not visible to the human eyes, and the experimental rooms are not accessible during experiments with accelerated particle beams. These phenomena are often not visible even with special cameras. Physicists observe graphs and study data to understand what is happening during the experiment. In this VR experience, however, the users find themselves very small and located inside a real particle detector (AGATA). Witness fireworks represent particle collisions. When the fireworks disappear, 3D information on the passage of photons appear (to explain a feature of this specific scientific instrument that consists in advanced tracking) and a constellation of formulas surrounds the user, symbolizing the work of the researchers who think and interpret these phenomena.

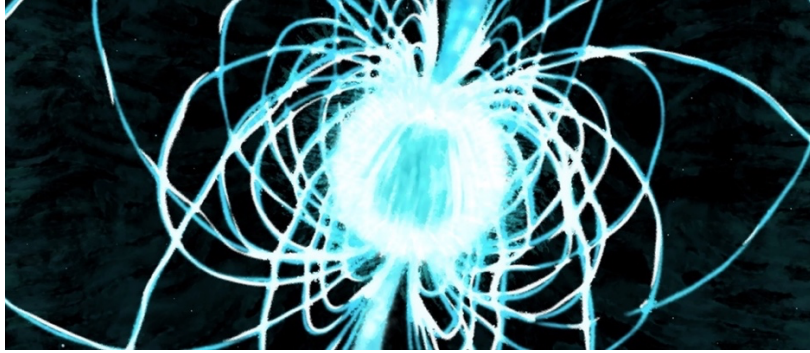


**Figure 7.** Nucleosynthesis VR Experience, 2021. Still of the collision event. Own work.

It would be completely incorrect to represent a nuclear physics experiment in this way, as an explosion of sparkling fireworks or as formulas suspended in the air like ghosts. But the artistic nature of this project is so evident that the metaphorical exaggerations are made acceptable and useful. One of the scenes in this VR experience even features a sun with a lock (as if it were a door), to represent the mystery of stellar nucleosynthesis that can be unlocked with the data recorded during the experiments. Users should understand that stars do not have locks, but it is still very exciting to see your key finally reach the sun.

The second example, *Pulsars, A Tale of Cosmic Clocks*, produced by Virtual Immersions in Science (VIS) and 15L FILMS, is a short film aimed at young viewers that combines live action and animation: Alma, a young girl,

embarks on an unexpected journey into space, led by a mysterious scientist. What was supposed to be a simple trip to the museum turns into her life-changing adventure. At the centre of the journey there are pulsar stars and the surprising story of the young scientist that discovered them. The animation style is very far from realistic representations of astronomical phenomena: it is stylized but full of careful details such as lively brushstrokes, but above all it is scientifically accurate.



**Figure 8.** Pulsars, *A Tale of Cosmic Clocks*, 2022. Still from the film. Own work.

'Pulsar is an unprecedented film project that brings together storytellers and scientists.

We asked ourselves, how can we tell a captivating story about the cosmos without losing sight of the accuracy of scientific information? The result is a short film aimed at young viewers that combines live action and animation.

We also wanted to deal with the issue of girls' access to the study of science and the gregarious role that women still have in the sector today. It seems important to us to state that today any young person can take an interest in astrophysics.

Cinema can also be an artistic and informative tool at the same time.'

(Bruna, Guerra, 2022: [www.vis-sns.com/products/video/pulsars-a-tale-of-cosmic-clocks/](http://www.vis-sns.com/products/video/pulsars-a-tale-of-cosmic-clocks/))

This movie is the winner at the Ciencia en Acción 2022 and at the Raw Science Film Festival 2022. Products of this kind are achievable thanks to teamwork, involving experts, artists and scientists. A multidisciplinary team can encourage the adoption of different points of view and the exploration of wider problem spaces to design solutions suitable for the general public.

The third example, *INFN-LNL Introductory Video*, is a short documentary video that describes the history and activities of the National Laboratories of Legnaro of the National Institute for Nuclear Physics (INFN-LNL). This video features a mix of stylized and abstract animations, special effects with holographic overlays of 3D models (from original CAD files) on real footage, collages of photos, motion graphics and unaltered normal shots.

The presentations of the Laboratory in this video include the use of 3D maps of the floor plans and sectional views, which, though impossible in reality, aid in understanding the complexity of the scientific apparatus often interconnected underground between different buildings.

In some scenes, the animations are drawn with a pencil line and painted on paper to give the idea of being something simple to understand, as if it were a product suitable for an audience of very young people.

Both the paper-looking animations and the holographic special effects are drawn in a way not to be misunderstood: the drawn illustrations can be overly simplified, which is what you can expect from a drawing that seems more artistic than scientific. The 3D technical CAD models are inserted into the videos with holographic precise and detailed style because these contents are real, they are simply inserted into a different context: instead of being on the PC screens they are inserted on the real images to allow the public to see what is inside the objects. This style is in clear visual contrast with the paper style and is also in contrast in terms of meaning to avoid misunderstandings and to strengthen communication.

Animation was used with the purpose to simplify complex concepts about nuclear physics and to encourage the public to listen to explanations of these complex topics.

The last example is *Viaggi Riflessi, holograms and simulations*, an installation exhibited in *Stars and Travels 2021* in Venice. The installation consists of a pair of looping videos presenting a 3D simulation with light effects based on photogrammetry of two bas-reliefs from the Cycle of the Months in the St. Mark's Basilica in Venice. The bas-reliefs have been virtually enhanced with metallic stars. The simulation showcases holograms of the relief panels with the applied stars. The bas-relief with the stars becomes a starry sky revealing the corresponding constellations. Artistic concept for a hypothesis in archaeoastronomy.

In this case the holograms represent something impalpable: a theory, a virtual simulation. In fact, the artistic installation envisages that someone can try to touch these transparent 3D models by crossing them with their hand, because even if this theory on metallic stars was real today it would not be palpable as we would like to do.

The simulation may still seem real enough to give a good idea of what this theory predicts but, to be honest, it does not show it in a too real or too concrete way, exploiting this problem in a poetic artistic solution that allows you to reflect on the topic.

Reflection is a key concept in this project because these metallic stars, inserted into the bas-reliefs, could have shown the sparkle of the star map during sunrise and sunset, when the sun reflects its first and last light in a particular way onto the Cycle of the Months of the Basilica of San Marco.

## 7. Conclusions (AL)

To create the holograms for *Viaggi Riflessi* there was a style design phase that attempted to create something accurate but at the same time responsible. It is not obligatory, today, to set linguistic or symbolic limits when representing scientific concepts. There are conventions that can be overcome. Communication teams often do not consider the impact that misinterpretations could cause and how to prevent them.

It is difficult to compete with the aesthetics of fake images that have potentially no limits, and that are designed to capture people's attention.

Speaking of aesthetic advantages and engagement, it may be necessary to consider that cinematographic visuals, that can be extremely powerful and captivating, are suitable for various contexts, not just for entertainment contents that are competing against scientific images making them more

boring and confusing the meanings. A long time has passed since the term edutainment was coined to classify those entertainment products suitable to education (Zhu Feiyue, 2022) but the old challenges still remain open: balancing accuracy and engagement; the coexistence of competing contents made with similar languages but used by different domains about the same topics; the confusion and misunderstandings that can arise from blending boundaries and decontextualization.

Today there are many visual competitors to science products and many bad sources of information. Artificial intelligence, fast information designed to work with short attention spans, pictures inflation, fake news, unethical neuromarketing, hyper realistic contents for entertainment are competing against authentic scientific visual contents (Szabo, 2014; Quaranta, 2020). How should we do good visual communication for science? Should we establish guidelines to clarify meanings and to moderate expectations regarding certain visual content? Should we divide the different domains that deal with the same topics, clearly differentiating them in style even with science fiction?

An effective solution could be to define a multi-level framework to be specified every time to distinguish the nature of the image shared, including the purpose for which it was created and where to find the sources. A research organization could use this framework as a standard for their communication projects: original data usable for research purposes, accurate simulations intended as predictions based on theories, content designed to communicate something, artistic interpretations. It is not just about freeing journalists from this responsibility by applying labels, it's about providing tools to distinguish media content and purposes and, at the same time, training people on train to distinguish and evaluate what they are seeing to avoid unexpected exploitation and misunderstandings.

In the absence of a clear and unequivocal framework and in the absence of a common culture in which people expect to be informed about what is proposed to them (as has happened in Europe with information regarding privacy and as is happening with the products generated by generative artificial intelligence), it is still possible to create honest but at the same time attractive, exciting and effective communication projects, considering the complexity and importance of this topic already in the very early planning stages.

This arises from the urgency of teaching people to distinguish types of images from each other even when they may seem very similar and support them in seeking clarification regarding what they are seeing. This strategy would also lighten the work of debunkers and allow this kind of culture to flourish in support of the digital literacy that is necessary today to live in the information society and web 2.0, a collaborative web that can increase the amount of knowledge available but also pollute and confuse information. Science communicators and researchers operate in this information system, and they can make a difference in the evolution of information pollution by supporting their audience and, circularly, themselves.

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