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Memorie della

The metaverse to interact with stars

A virtual exhibition at Palazzo Esposizioni Roma

L. Leonardi[1], and L. Daricello[1]

Istituto Nazionale di Astrofisica – Osservatorio Astronomico di Palermo, Piazza Parlamento, 1, Palermo, 90134, Italy e-mail: laura.leonardi@inaf.it

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Abstract. On the occasion of the INAF exhibition "Macchine del Tempo - Time Machines", inaugurated on the 25th of November 2023 in Rome, we developed an interactive experience by using the technology of the metaverse, to reproduce virtually one of the halls of Palazzo Esposizioni Roma. Inside this virtual space, we exposed the 3D models of extremely energetic stellar objects, such as supernovae and stellar jets, as if they were "stellar works of art" or statues, accompanied by images, captions, and an audio guide. Frame is the web-based software that we used to create this experience. In this article, we intend to present this tool as a case study to open a discussion on the opportunities and limitations provided by new technologies like the metaverse. In particular, we will illustrate its potential for education and outreach, the problems faced during the design, and the difficulties encountered.

Key words. Metaverse, Exhibition, Virtual Reality, Digital Twin

1. Introduction

The exhibition of the National Institute of Astrophysics (INAF) "Time Machines" (Aloisio et al., 2023), took place from November 25, 2023, to March 24, 2024, at the Palazzo Esposizioni Roma. Promoted by the Department of Culture of Rome and the Palaexpo Special Company https://https://www.palaexpo.it/ which manages the Exhibition Centre, it was conceived by INAF in collaboration with Pleiadi Science Farmer https://www.pleiadi.net/ to talk about astrophysics and astronomy to everyone, young and old, beginners and enthusiasts, combining scientific dissemination and gaming, winking at the style of the '80s. The exhibition's main objective was to introduce astrophysics and INAF's participation in recent great discoveries, through a path made up of interactive exhibits, photos of telescopes and satellites, engaging sounds, video games, virtual reality, and much more.

What are the time machines? These are the results of scientific research, to which INAF contributed significantly, to expand our knowledge of the cosmos. The exhibition was divided into three sections where visitors embarked on a real "journey through time" whose central theme was the light that with its speed allows us to see not only the present but also the past.

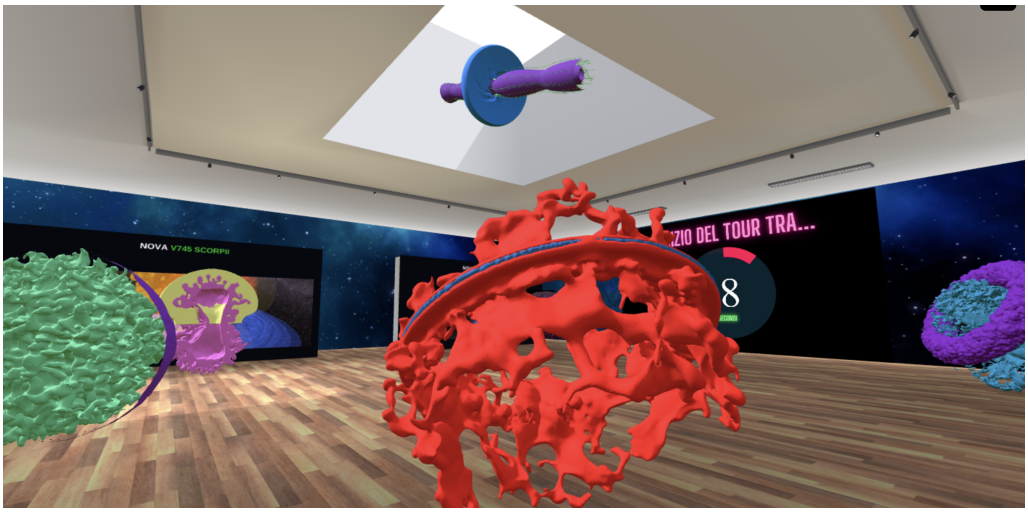

Fig. 1. The ”augmented” space of Palazzo Esposizioni Roma where to observe stellar objects shown as if they were statues or paintings.

A variety of educational interactive experiences were part of the exhibition. Among these, there was a tour in the metaverse inside the ”augmented” hall of Palazzo Esposizioni 1, to hunt for stars and stellar explosions. The virtual experience is called ”MuMAs” (Museum of Astronomical Models) (Leonardi et al., 2023) and was presented for the first time in 2022 during a plenary session of the Inaf's education and dissemination group, and the INAF's national representative for public engagement, Caterina Boccato, wanted it to complete the educational offer of the exhibition.

2. What metaverse can do?

The word metaverse first appeared in Neal Stephenson's sci-fi novel ”Snow Crash” published in 1992. The author described it as a huge black sphere on which each person could build in three dimensions whatever they wanted (Stephenson, 1992). A reality 2.0 potentially visitable by other virtual users. Using this idea and the opportunities offered by the physical space of the Palazzo Esposizioni Roma, through the use of headsets, we extended the exhibition to a virtual exhibition hall, displaying the 3D simulations of astronomical events at very high energy, obtained from astronomical data (Orlando et al., 2019) from space telescopes such as Hubble, Chandra, and XMM-Newton, namely, time machines. The activity consisted of a three-dimensional space in which individuals could interact and collaborate, even using their voices, and where three-dimensional avatars represented users in a network of interconnected virtual worlds through the Internet and from any device, including virtual reality headsets and mobile devices (smartphones, tablets). The experience was developed with Frame `http://learn.framevr.io/`, an open-source metaverse development software allowing users to interact with the experience and other users through a virtual reality headset and a simple laptop. To access the museum room in the metaverse from a virtual reality viewer, for example, by Meta Quest, you must wear the viewer and open the proper browser page. Frame is built with babylon.js `https://www.babylonjs.com/`, a 3D open-source web development framework from Microsoft with which Frame developers have a partnership. 3D environments are created with Blender, and there is also a wide variety of other technologies used in Frame, such as webrtc `https://webrtc.github.io/`, Vue.js `https://vuejs.org/`.

As a system requirement, Frame needs just an internet connection. Everyone can enjoy the experience in the metaverse at any time without downloading or installing any program.

Metaverse with Frame allows (i) Real-time interactions: users can explore the virtual environment and interact with other connected users at the same time and in the same environment via chat and voice as in video conference; (ii) Usability: in addition to the basic programming skills, there are sophisticated tools for nonprogrammers, developers, and artists that allow you to customize space in the metaverse in unique ways; (iii) Analytics: it is possible to generate analytics and data to track participants, length of stay and level of interest, notification access via email; (iv) Digital Twin and Artificial Intelligence (AI): Users can create a Digital Twin and interact with the virtual objects inside the environment remotely and generate 3D models with AI within the workspace, by writing a text message or using a reference image.

For all these reasons, we thought it was an extraordinary tool to tell the story of INAF's research at the exhibition "Time Machines".

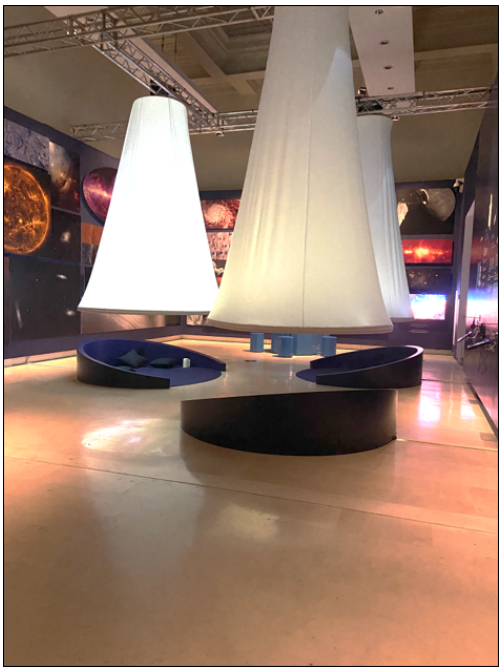

Fig. 2. One of the halls of the exhibition "Time Machines" at Palazzo Esposizioni Roma, in Rome.

3. Virtual and real setting

The virtual hall in the metaverse has been adapted, in style and colors, to the real exhibition spaces 2. The setting in the metaverse was designed to help the general public feel of being still inside the exhibition but with the opportunity to watch a stare close-up. Through the metaverse, we intended to highlight INAF's efforts in developing physical models of astronomical objects, as well as emphasizing the significance of studying the evolution and chemical composition of highly energetic stellar objects to deepen our understanding of the universe. Events such as supernovae help to form the elements of life, such as iron in our blood and calcium in our bones, confirming that we are made of the same substance as stars.

Users of the metaverse, visiting the exhibition "Time Machines", were able to experience a journey in time and space to learn about the history of "stellar works of art" and to discover how stars are born, develop and end their existence. Supernova explosions, such as Sn 1987A in the Large Magellanic Cloud, the stellar remnant of Ic 443, also known as the Medusa Nebula, powerful star jets produced by a forming star, or U Scorpii, a system of two binary stars interacting with each other constrained by gravity in the constellation of Scorpio, all of these are just some of the 3D models that have been possible to admire. The 3D models presented in the virtual room are produced from space-time data captured by spacecrafts in space. They were not just a figment of someone's imagination but they derived from the numerical analysis of astronomical data used by researchers to study the composition, structure, physics, and evolution in time and space of these objects.

Within the virtual experience, a video and a voice-guided tour provided detailed explanations of the models displayed in the hall. The tour was also translated into English, with subtitles included in the video. Visitors could ex-

plore the models, immerse themselves in stellar remnants, admire images captured by space telescopes, and interact with other visitors in the same virtual room if the experience was shared. The tour lasted five minutes, concluding with the voice guide giving instructions on how to remove the VR headset and return to the real exhibition. A one-minute countdown then marked the beginning of the next cycle of visits.

4. Problems found

The experience in the metaverse was launched during the opening night and was greatly appreciated by communication experts and the general public, but after a few days, it was put aside for the following reasons, which were already raised but not faced during the set-up phase of the exhibition. The experience required an internet connection, and the one of Palazzo Esposizioni Roma was not sufficiently performing. Another problem was the handling of the headsets. It needed the constant presence of qualified staff to guide visitors in properly enjoying the virtual experiences, while there were just sometimes the personnel that oversaw the entire exhibition, who occasionally assisted visitors with putting on and removing the headsets. People can join the metaverso exhibition online, by visiting the official website page `https://framevr.io/mumas2inaf`. On Play.inaf site `https://play.inaf.it/` one can read all the instructions to follow and discover the astronomical objects observed with time machines both on a computer and VR headset. People can also find further explanations in the second issue of Universi, the official journal of Inaf `https://universi.inaf.it/`.

5. Conclusions

The metaverse is a disruptive technology that will impact society in the coming decades, enabling immersive experiences in both virtual and physical environments. It makes the physical and digital universes converge, thus allowing users to travel back in time, exploring immersive environments to work, learn, and socialize with others. The US analyst Matthew Ball defined the metaverse as a space for interaction between users around the world (Ball 2022). A place unconditioned by the dynamics of space-time where users from all over the globe, even if they connected simultaneously, could enjoy the same contents without distinction, in real-time and without any connection limit; a digital space with endless entertainment possibilities; an experience that combines the physical world with virtual reality, ensuring full interoperability of data and information.

ONGOING AND FUTURE SURVEYS - We are planning activities aimed at both school and university students, to explain the potential of this tool and how to use it to carry out their science communication activities. Part of the work already completed is described in the article "The wow effect is out-of-date", present in this volume.

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