7. Holography and its many types of applications in Photonics “Virtual reality example: a cosmological model”

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A “cosmhological” model of the universe is proposed. Using present and future developments of Augmented Reality (AR) we reanalyse the state of the art present possibilities. We propose a new type of data presentation. A “cosmotarium” or “Holoverse” which would be like an encyclopedia but would display in Multiple dimensions all known things. We present some preliminary results of the design of a “cosmhologram”.

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Introduction

Roughly a century after the pioneers (Lippman, Gabor, Leith, Denisyuk…) a new word (Optoclone) has been patented to describe Holography… We briefly review the main optical architectures and technologies used today in enterprise and consumer Head Mounted Displays (HMDs), over a range of implementations including smart glasses, smart eyewear, Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR) headsets.

In addition to the optical architecture review, we discuss the human immersive experience and the need for a human centric optical design angle to come up with the most comfortable headset without compromising the user’s experience (display, immersion, sensing, interaction). We discuss the major optical challenges to overcome in order to provide the user with the visual and sensory experience that will eventually enable the market analysts’ expectations for the coming years in all the headset declinations. These challenges range from wearable and visual comfort to sensory and display immersion. We then discuss some models of Universe including a new model which is coherent with Lavoisier's saying: “Nothing is disappearing, nothing is created, all is evoluting and transforming itself”. And finally apply the principles of the first part of this paper to define a representaion of a model of “Holoverse”.

Modern systems of Presentation and Representation

Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR) technologies and headsets: Head Mounted Displays (HMDs), their ranges of implementations including smart glasses, smart

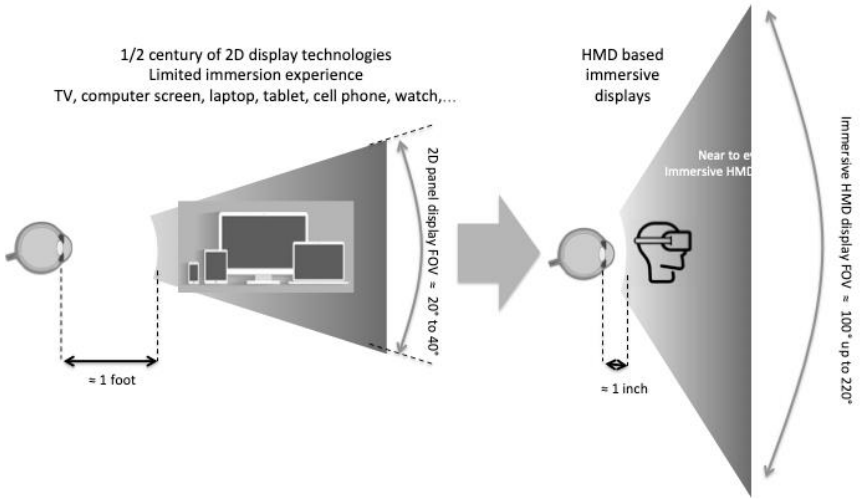

Fig. 1. Immersive NTE displays: a paradigm shift in personal information display

eyewear, etc... The immersive display experience in AR/VR is a new paradigm shift (1) from traditional panel displays experiences since more than half a century, starting from CRT TVs, to LCD computer monitors and laptop screens, OLED tablets and smart phones, LCoS, DLP and MEMS scanner digital projectors, to iLED smart watches (See Figure 1).

But the words and concepts "Holography", "Hologram", "Holographist" etc... were designed and proposed by Denis Gabor in 1949. And since that time 3D representations have been improved in size, depth, color and animation (2). But nowadays they are still very limited... and expensive... Let us consider some present days solutions:

Stereo Cameras

Stereo cameras simulate human binocular vision by measuring the displacement in pixels between the two cameras placed a fixed distance apart and use that to triangulate distances to points in the scene. Conventional sensor arrays (CMOS) can be used. Parallax (thus depth resolution) in stereo cameras is a function of the camera separation, thus increasing potentially their required sensor bar footprint.

Structured Light Sensors

Structured Light sensing works by projecting an IR light pattern (grid, fringes, spot patterns, etc...) onto a 3D surface and using the distortions to reconstruct surface contours [127]. Ideal projectors are Far field pattern projectors such as Fourier CGHs (Computer Generated Holograms). CGHs work well with IR lasers or VCSELs around 850–900 nm. The sensor does not need to be custom (CMOS). FOV (both in projection and sensing) and also lateral resolution limit their reach. Popular structured light depth map sensors are the Kinect 360 (Xbox 360) from Microsoft Corp., the Structure sensor bar from Occipital Inc., the RealSense sensor bar from Intel Corp, and the depth sensors on Magic Leap One MR headset.

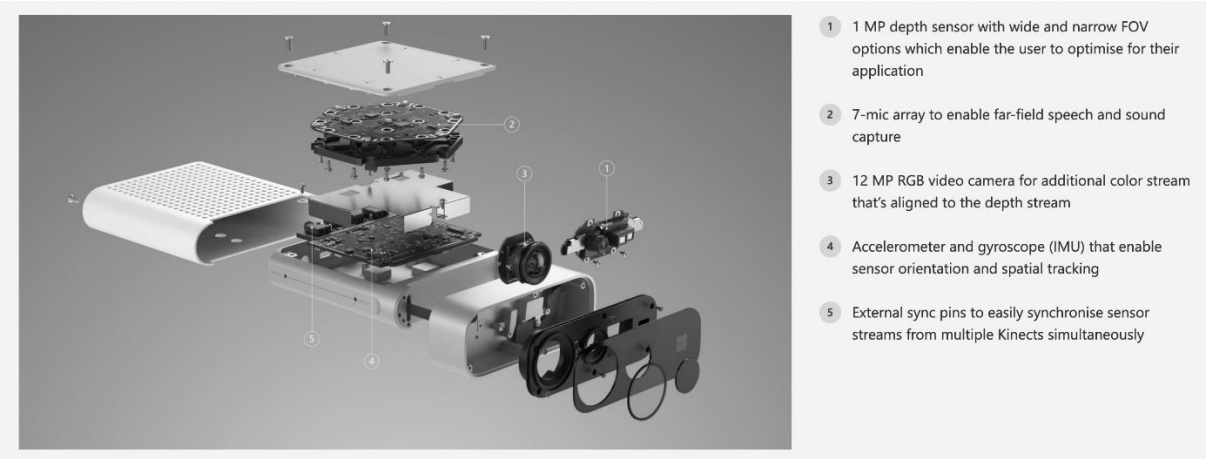

Fig. 2. The 2019 RGB-D TOF Kinect Azure depth map sensor by Microsoft Corp

1.3. Time-of-Flight Sensors

TOF sensors work by emitting rapid pulses of IR light that are reflected by objects in its field of view [128]. The delay of the reflected light coming back is used to calculate the depth location at each pixel in the angular space. Such sensor architectures can be implemented with a 2D scanner and asingle detector, a 1D source array scanned in the orthogonal direction and sensed back onto a linear detector array, or a single pulse light sensed by a 2D detector array. More sophisticated TOF sensors encode the phase rather than the amplitude. Such sensors chip layouts can be highly custom [130]. Double or multiple reflections are one of the limitations to overcome by TOF sensors. A popular TOF sensor is the Kinect One (Xbox One) and its modified version on Hololens V1 and V2, from Microsoft Corp. Figure 2 shows the newly disclosed 2019 Kinect Azure RGB-D depth map sensor from Microsoft Corp., of which a version has been integrated in the new HoloLens V2 MR headset.

All those sensors (stereo cameras, structured light and TOF) have their specific features and limitations. Most of them are based on IR illumination and have a hard time functioning outdoors in bright sunlight can wash out or add noise to the measurements. But no problems when looking at the night sky. B&W stereo cameras have no problems working outdoors and consume less power, but they work best in well-lit areas with lots of edge features and high contrast.

2. General Information Display Problem

Still, during this period the idea and the initial concept spread and gave rise to new ideas and concepts (including in the field of cosmophysics)… for which new words were created: Holistic and Holistic Principle, Optoclonic Technologies etc…

A particular approach is one that seeks to maintain coherence in both the theoretical and experimental abundance of contemporary physics: Principles that are completely accepted and used in one field can sometimes be completely contradictory to those applied in another field. I'm not just talking about the food biophysics sector (where the research and the commercial part both use holograms but where debates between ecologists and productivists fill the TV screens). But in more fundamental physics, the principle of Heisenberg is for example, contradictory with the absolute

speed of the light in the vacuum, and the fact that we see the lamps… Subjects, eras, modes, experimental procedures and theoretical models have been developed which have proven to be very effective and useful in certain fields (3)… But have been the subject of reservations and harsh criticism from others points of view and areas… The current controversies about Boeings aircraft nailed to the ground or on the climate are striking examples… They are not more serious in engineering than in science… The current "reform" of the International Weights and Measures System is a recently publicized consequence. We have a real need to reassess both our thoughts and our practices. The expression of new ideas and critical analyzes of our traditional ideas is indispensable!

3. Universe Models

Since prehistoric times people have wondered where things ans themselves come from. Many models where proposed, initially by metaphysicists, then by mathematicians, more receently by physicists. Some where "creationists" other "statics" other "chaotics". The word "Metaphysics" or "Transcendence" means "out of physics" and for Academician Lalande (1780): "Knowledge that does not result from the natural play of a certain class of beings, actions or reflections, but presupposes the existence and intervention of a principle external to nature."

3.1. "Big Bang models"

The so-called "Big Bang model" is a tentative of description of the origin and evolution of the Universe from the beginning of the 20th century. In general, the term "Big Bang" is associated with all the theories that describe our Universe as resulting from a rapid dilation. By extension, it is also associated with this dense and hot epoch that the Universe would have known 13.8 billion years ago (without necessarily prejudging the existence of an "initial moment" or a beginning to history). The term was originally proposed in 1927 by the Belgian astrophysicist and canonist Georges Lemaître, who outlined a model of a Universe in expansion, initially proposed by the American astronomer Edwin Hubble in 1929. The general concept of the Big Bang, namely that the Universe is expanding and has been denser and warmer in the past, must probably be attributed to the Soviet physicist and mathematician Alexander A. Friedmann, who proposed it in 1922, (five years before Lemaitre). This model was designated for the first time under the ironic term "Big Bang" on a BBC broadcast, "The Nature of Things" in 1949, by British physicist Fred Hoyle who preferred stationary state models.

3.2. The "Cosmhological Model"

In this model there is no "beginning" or "end" of the Universe. On the one hand it is likely that the development of experimental techniques and the correlative improvement of the theories in optics (LASERs, Holographic Optics, Photonics, etc.) may soon allow very great improvements in observations. New experimental data is collected daily by a number of instruments that did not exist a few years ago On the other hand, new theoretical considerations try to take into account these new results. Some to integrate them into existing theories. Others to serve as bases for new theories.

The "Cosmological Model" (developed by our team) is an example (4): It assumes a Visible Universe limited by the speed of light but integrated into a larger Universe. We can make the analogy

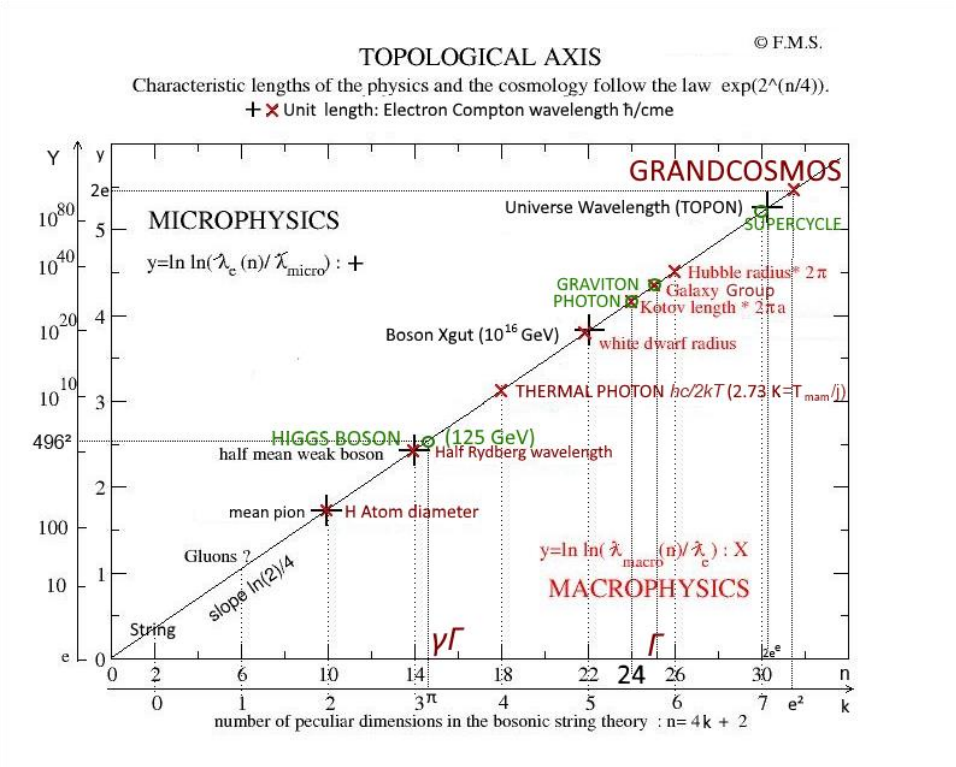

Fig. 3.

with a molehill, at the top of which moles very short-sighted and do not see to the base of the molehill, have imagined a limited Universe at the top of their molehill. But who, developing instruments, allowing them to enlarge their field of vision, discover little by little, that at the bottom of the molehill exist perhaps “things” (earth, blades of grass etc...) that they try to represent themselves. . . by arguing between her about the different “models” possible. . .

By applying the principles of thermodynamics (which are already controversial at the level of the planet and global warming) to the Universe, it is possible to imagine a cyclic universe of very large dimensions. In the past, “close” spaces (on a human scale) belonged to physics, “far-off” spaces (very large or very small) from metaphysics... Today, the development of instruments and concepts is progressively increasing the areas in which physics can be exercised... But metaphysicists have always vigorously defended their “opinions” and “domains” and continue to do so. Every human being “lives” in a certain “volume of space-time”. The outlines of this volume are unclear: They begin with his gestation as a foetus his education by his elders... and end with decrepitude, agony and death! And during his life he sometimes thinks, but by far not always... and he only “memorizes” his thoughts, more or less well!

This situation lasts for a few million years believe us... But it is only a few centuries ago that Descartes stated “I think so I am!” One of the bases of what we call physics today. Although the reasoning has been extended to the fact that we can “think” of physics only by interacting with each other... at the level of “thinking” groups that everyone dreams ofuniversal but who are only more or less extensive... Fragmented as we are by language, culture, belief, knowledge... (and basically our space and time of existence wether as individual or human group).

Topological axis: double logarithm display of large numbers appearing in micro- and macro-physics. The x-axis numeration shows the string theory special series [4]. The Y axis corresponds to the String dimension series $n = 4k + 2$, from k = 0 to k = 7, showing the Cartan-Bott periodicity 8 [25] which is at the origin of the name ‘topological axis‘. With unit the Electron Compton wavelength, in the macro-physics side, the Universe circumference is tied to bosonic critical dimension 26, while reduction lead to n = 18 (thermal photon, tied to the the mammal wavelengt throught the Sternheimer scale factor j), n = 10, (superstring dimension, Hydrogen atom), and n = 2 (String). For the number 24 of transverses dimensions, it is the Kotov length (5), through a factor 2πa, with a = 137.036.

For n = Γ, the Atiyah constant, it is the galaxy group radius, a characteristic cosmic length (106 ligth-years).

For k = e2, y = 2e, it is the Grandcosmos radius.

With the same unit, the Electron Compton wavelength, in the micro-physics side, the Space-Time-Matter Holic dimension n = 30 is tied to c times the cosmic Supercycle period, while reduction lead to n = 22 (GUT bosons, 1016GeV), n = 14 (weak bosons) and n = 6 (massive gluons, about 10 MeV). For the superstring n = 10, it is the Pion.

For k = π, n = γ × Γ, Y ≈ 4962 the square of the String dimension and the tenth root of the Monster cardinal, it is the Higgs boson (125 GeV).

For k = 2e, it is the Topon, the visible Universe wavelength, which identifies with the monoradial unit length of the Universe Bekenstein-Hawking entropy. With unit the electron mass, n = 24 would correspond to the graviton mass, while n = Γ, to the graviton mass. With unit the Kotov length, the Holic dimension n = 30 corresponds to the Monster cardinal, apart a $\sqrt{2}$ factor. The central dimension is n = 16, suggesting that the whole scheme is tied to the Eddington’s matrix 16 × 16.

4. Conclusion

Different optical technologies are being developed for VR (Virtual Reality), AR (Augmented Reality), MR (Mixed Reality) and smart glasses… We will show some examples of realisations during the presentation and present in the paper a case of conceptual utilisation in Cosmophysics.

We feel that the present theory of « creation of the Universe by Big Bang » is full of contradictions.

We propose a different model (6) which seems to fit (not completely but) much better with existing experimental facts. Extending at a much bigger space-time scales than previous propositions. According with already existing wordings we call it HoloCosmos or CosmHological model. We define a “space-time-matter” coordinates system in coherence with the new “fundamental constants” definition of the “International Commission of Weight and Measures”. In this model different important parameters taken from “micro”, “MACRO” and “human size” physics align themselves on a straight line. This shows a great unicity in the different descriptions of Nature, in spite of some still existing great contradictions:

– Constant speed of light versus Heisenberg Principle

– No experimental discovery of Tachyons since 1962

– etc…

But it solves completely such problems as Black matter, Black energy etc … And creates new experimentl tests ideas which could be tested in the near future (for instance in 2 years from now). Especially about different properties of “light” (7) which have not yet been given much interest in Astrophysics. Like Polarisations, Coherence, Phase, etc … The combination of new sensors, new concepts and basic definitions and new display systems allows to improve our description and understanding of nature: One can think of a new type of “encyclopedia”. Not any more only words on paper, but full 3D interacting universal representation of “everything” from smallest to biggest!

Bibliography

[1] **Kress**, **B.** Towards the ultimate Mixed Reality Experience: HololensDisplay Architecture Choices / B. Kress, W. Cummins // S. I. D. 2017 Book 1: Session 11:AR/VR Invited Session 2.

[2] **Kress**, **B.** Applied Digital Optics: from Micro-Optics to Nanophotonics / B. Kress, P. Meyrueis // J. Wiley and Sons Publishers, 2007. — ISBN 10: 0470022639.

[3] **Hua, H.** Optical methods for enabling focus cues in head-mounted displays for virtual and augmented reality / Hong Hua // Three dimensional Imaging, Visualisation and Displays. Proc. of SPIE. — 2017. — Vol. 10219

[4] **Sanchez**, **F. M.** (2013) Towards coherent cosmology. Galilean Electrodynamics 24(4):63

[5] **Kotov**, **V. A.**, Lyuty V. M. (1990) The 160-min periodicity in the optical and X-ray observations of extragalactic objects. Compt. Rend. Acad. Sci. Paris 310, Ser. II:743;

[6] **Sanchez**, **F. M.** Towards a synthesis of two cosmologies: the steady-state flickering Universe / F. M. Sanchez, V. A. Kotov, C. Bizouard // J Cosmol. — 2011. — Vol. 17. — P. 7225

[7] **Grosmann**, **M.** Holography and molecular spectroscopy / M. Grosmann P. Meyrueis // Journal of Molecular Structure. — 1978. — Vol. 45. —P. 365–379.