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Flowers behind the back of the universe: A cosmic art project exploring the invisible

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ABSTRACT

What can be seen within this universe? Since humans are not instinctively aware of the limitations of their sensorium, what is being missed is not immediately obvious. Aiming to explore with our imagination the invisible elements in the universe, we created an interactive cosmic art project in collaboration with the Gunma Astronomical Observatory, and the Polytech Festival in Moscow.

In this paper, we firstly address the topic of dark matter, from the physics point of view, the concept in our project touching upon the invisible beauty in the universe, and then discuss the practical methodology for the process of making the installation. This installation was laid out based on a map of constellations from where people were able to see the antipode of Moscow, an opposite point from the venue where the installation was set, in analogy to illustrating what exists, but can not be seen.

Using origami flowers - made in the course of a workshop by the visitors of the festival - as a metaphor of the beauty and transience of life, the installation seeks to deepen the awareness of participants about the numerous invisible structures in the universe. Placing them within reflective structures underlines both our reliance on technology to make the invisible visible, and the influence of the point of view on how we perceive and interpret the resulting representations. In their various forms and colors, these flowers can be seen as metaphorical mirror images of that which lies at the antipodes of our awareness: of colorful gas glowing in radio waves, supernovas in their many x-ray hues, dark matter, neutrinos, gravitational waves, dark energy. Considering both the invisible scenery of the sky and the invisible elements of beauty in the universe as lying behind the 'back' of the universe, hidden to our senses, this project explores a new way of communication between humans and the ubiquitous invisible in an artistic manner.

Finally, the whole process of this project is summarized in order to suggest future directions for our transdisciplinary collaboration.

1. Introduction

The 'observable universe' extends to 13.8 billion years, back in time to shortly after the Big Bang occurred. In spite of ever - deeper exploration, approximately 95% of the universe still remains unknown. Yet, if we were able to feel what we do not see, what would it tell us? (see Figs. 1 and 2)

There have been many cases where researchers try to visualize the invisible elements in the universe, or to sonify these through digital technologies. A certain degree of abstraction from scientific data would be needed in order to get a deeper sense of understanding and imagination which allows us to go beyond a scientific scheme. And beyond the scientific knowledge itself, a more intuitive way of collaboration can be explored in order to enrich our way of life by using that knowledge. However, we are living in an era where the current established academia tends to have difficulties in an integration of human potential, missing the connections among the rigid disciplines.

Assuming that both artists and scientists are trying to unveil the unknown in the universe in different ways, at the fundamental level, we would like to approach this 'unknown' from both an artistic and scientific perspective.

This paper discusses our collaborative project named *Flowers behind*

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Fig. 1. Composite image of the MACS J0025.4–1222 cluster. Gravitational lensing was used to calculate the distribution of dark matter (blue); X-ray imaging to measure the distribution of hot gas (red). In the collision between the two underlying clusters, the gas was slowed down and heated, while the dark matter was essentially unaffected, image credit: NASA, ESA, CXC, M. Bradac (University of California, Santa Barbara), and S. Allen (Stanford University).
(image from https://www.nasa.gov/sites/default/files/images/270896main_print_full.jpg), [1]. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

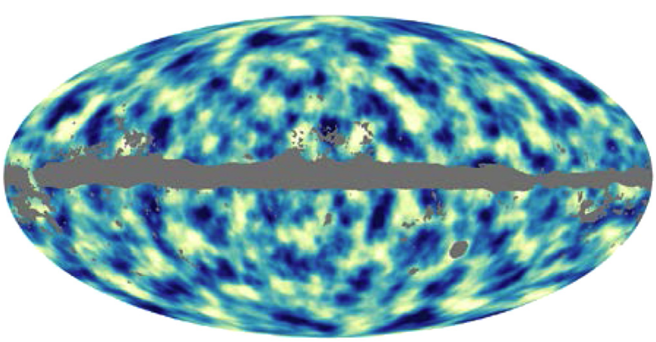

Fig. 2. All-sky map of dark matter distribution in the Universe as determined via gravitational lensing in the Planck cosmic microwave background sky-map.
image credit: ESA and the Planck Collaboration (image from http://sci.esa.int/science-e-media/img/94/Planck_all_sky_dark_matter_distribution_orig_v3.jpg), [2].

the back of the universe. The project was presented at the art and science festival called the Polytech Festival of Science, Art & Technology organized by the Polytechnic Museum.

Aiming to explore our imagination towards the invisible elements in the universe, this project was developed in collaboration with an artist, a designer, a physicist, the Gunma Astronomical Observatory, and the staff and the citizens of Moscow.

The discussion begins with a physics insight into dark matter, then explores the underlying concepts about the project, the process of the project (including methodology of both workshop and the installation, the result), and finally suggests our future directions.

2. Setting the invisible stage

For close to a century, there have been hints that only a part of the matter making up the universe is in the form of luminous stars, the rest being invisible. However, it is only in the last decades that it has become clear that this dark matter far outstrips the normal (baryonic) matter, and its identification is now of highest priority.

2.1. Looking into the dark

Astrophysics (and physics in general) is in an ‘interesting’ situation: thanks to indirect observations, the existence of dark matter is almost impossible to refute, and to some extent, a significant amount of information has already been extracted from these indirect measurements. Dark matter, which interacts gravitationally with matter (gravitational lensing), largely dominates the mass of the Universe (there is about five times more mass in the form of dark matter than in the form of visible matter, as determined from the cosmic microwave background). Dark matter interacts weakly with itself, if at all (as determined by the behavior of collisions between galaxy clusters and the study of dwarf galaxy structure), and has a lifetime longer than the age of the universe. Its possible mass ranges from 10^{-33} eV for ultra-light axion-like particles [3] to massive black holes (several $10\,M_{\odot} \sim 10^{67}$ eV [4], or even beyond [5]) - a shockingly wide range in which to search for it.

Within this range, theoretical and experimental ideas have blossomed over recent decades [6], with many attempts to explore possible candidates and their properties in different regions of this range, and with much of the focus on particles (that would have to interact weakly). Among these weakly interacting massive particles (WIMPs) on the low mass side of this range of dark matter candidates ($\sim 10^{12}$ eV), there is a vast (albeit empty) zoo of candidates, with a taxonomic plethora, among them such beasts as neutralinos, dark photons, gravitinos and axinos but also non-WIMP candidates such as Cryptons, Q-Balls or WIMPzillas. Direct searches at high energy physics particle colliders or with cryogenic detectors deep underground are sensitive to the lower end of the range, up to the scale at which the electromagnetic and the weak interactions combine into a single electroweak interaction. These experiments follow opposite approaches: colliders try to produce (new) types of particles; cryogenic detectors try to feel the ‘wind’ as the Earth flies through the fog of dark matter particles that permeates the galaxy.

At the other end of the scale, searches have looked for massive compact halo objects (MACHO's), planet- or stellar-size objects of ordinary composition that evade easy detection through the absence of light emission at optical frequencies and their low thermal radiation. These MACHO's can, however, pass through the line of sight between the Earth and remote stars, leading to short-term brightening of these stars as their light is gravitationally focused by the MACHO's, by which means a small number of such objects (albeit not enough to form the bulk of dark matter) have been detected.

The intermediate region, both for experimental and theoretical reasons, has been far less explored, with hypothesized super-massive dark matter particles (with masses up to 10^{28} eV–10 μg) having to address theoretical challenges to their existence. It is in that region close to the Planck scale that feebly interacting massive particles (“FIMPzillas” [7]) might exist. One concern is that such particles might have decayed, e.g. via virtual black holes, unless some symmetry protects them. But if they *are* stable, they would be essentially invisible.