

Looking for new interactions with dark matter

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The International Dark Matter Day, celebrated worldwide on October 31 every year since 2017, was first organized in Argentina in 2019 as part of an outreach initiative led by the ANDES deep underground laboratory collaborators. This effort has persisted over the years. In this work, we will discuss how in the last 2 editions, 2022 and 2023, we went from a model where we propose different kinds of outreach activities we developed ourselves, to a co-production model where we work with non necessarily dark matter related actors to build what we believe is a more significant communication of our topic. Specific activities such as a dark matter ice cream, card games, comics, and more will be detailed. We conclude our reflection with lessons learned from a public perception study we performed in schools.

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1. Introduction

The Dark Matter Day is, among numerous public science communication activities in the field of particle physics, a unique yearly opportunity to enter into diverse actions, particularly in relation to the theoretical frameworks that each local organiser adopts when constructing their proposals. These approaches, as classified by [1], can be either educational/dialogical or promotional/persuasive. Although finding purely educational/dialogical activities can be challenging, we decided to try to focus our efforts in this direction. To achieve this goal, we have decided to develop an exploratory strategy that we term "science injection" in environments where, a priori, there is no pre-existing interest in science or its communication.

In parallel, within the framework of studies on public understanding of science, we will aim at understanding pre-existing perceptions, ideas, and sensations surrounding the concept of dark matter and underground science. In this way, we aim to understand better the foundations upon which our dialogue about dark matter and science will be constructed.

Finally, in line with what was previously mentioned, our goal is not mainly to convey concepts about dark matter itself but to use it as a pretext for engaging in a dialogue about science, and fostering attitudes towards science and those who practice it. These attitudes include the confidence to engage in conversations with scientists, perceiving science as a constantly evolving process rather than a static product, understanding science as a procedure subject to trials and errors, and appreciating science as an inherently human activity.

2. Production of a card game

The first activity we worked on was similar to our previous efforts [2]. We decided to develop a card game that would allow people to step into the shoes of a scientist, exploring the world of scientific research, with different dark matter candidates, handling laboratories, staff, experiments, and with some specific humour related event cards. We called it Dark Matter, The Card Game [3]. This represented our first effort to develop a tool to explain the scientific process to a potential global audience.

This is the kind of effort that we call a production – the autonomous creation of content using our skills in communication, education, and research, without the collaboration of other professionals such as designers, illustrators, gamers, advertisers, artists, among others. Given the lack of experience and time to advertise such a product, our game suffered from a lack of distribution and therefore of impact, being mostly played by acquaintances or students at particle physics conferences. The feedback received was overly positive, with no negative feedback at all, a probable reflection of the highly biased sample of players of the game. This confirmed our impression that for more original approaches to be successful, a wider range of abilities is needed, and we decided to move towards co-production.

3. Co-Production

In order to achieve a more significant impact with enhanced dissemination while maintaining approximately the same team, we had to find interested counterparts to work on co-productions.

The first solution that we researched was following our effort in the gaming area. The gaming world has a very active community and in numerous games fanmade extensions are developed to enhance the initial gaming experience. We decided to immerse ourselves in the world of Lovecraft in the Arkham Horror LCG game. After some initial attempts at producing ourselves some fanmade content, attempts that have not yet come to light, we discovered a campaign titled "Dark Matter", considered as one of the top fanmade campaigns ever made for that game. Although the campaign itself did not apparently address ideas related to dark matter as a scientific concept, the question arose: Why was that campaign named "Dark Matter" in the first place? Is it possible to integrate scientific content without losing the essence of the game? Can we incorporate science-themed cards organically?

Over a couple of weeks, we engaged in conversations with the campaign creator and some interested individuals on Discord, a communication tool widely used in the gaming community. The campaign creator confirmed he chose the name based on the omnipresence yet challenging to perceive characteristics of Dark Matter, as they applied to the horror elements of the campaign. Topics related to science and scientific activity were explored, as well as game dynamics and potential actions. It is worth noting that these people we collaborated with here did not come from scientific or science communication backgrounds. As a result of this interaction, we launched 20 new thematic science cards for the campaign on October 31 2022 [4]. These cards had a highly professional finish, were very well received by the community, and are regularly referred to in the Discord. More than anything, they naturally met their public, which knew about the product and was very willing to get an upgraded version. Our task had only been to hijack this process injecting some science in it.

This process taught us that Discord is a valuable tool for connecting with gaming communities, facilitating contact, discussion, and the evaluation of the process and results of our productions. The impact was significantly greater when targeting an already established audience using such tools. Additionally, by aiming for a person-to-person and procedural evaluation, we obtained more honest and less biased opinions. Participants, being unfamiliar and primarily focused on creating a good game campaign, were motivated to stand out in an environment with numerous campaigns, and competition drove excellence in productions.

A year later, we repeated this process with a somehow related game, Marvel Champions LCG. We approached the Discord Marvel homebrew community with the idea of a Dark Matter related villain one would fight in the game, but were suggested to look into Marvel villains, as people prefer to play things they relate to, and the Marvel universe is a key element of the game for many of the players. We therefore decided to create a scenario where the Marvel villain Graviton uses dark matter to his plans. The resulting 27 cards were released on October 31 2023 [5] and were also very well received. We believe this approach to co-producing game expansions in the fanmade world has been quite successful and we will likely follow this line of work in the future.

Following these ideas of co-production, we decided to explore new senses, with the possibility of merging the culinary world with the scientific communication process. The initial idea was to create a dark matter beer (maybe mate-infused, a national drink in Argentina). Despite Bariloche, our institute town, being one of the reference for beer in Argentina, no brewery in the city showed interest in a beer-science collaboration. We then shifted to the idea of ice creams, another speciality of Bariloche. We thought different complexities and flavors could initiate interesting conversations

with the audience on the Dark Matter Day. After visiting several establishments in the city center, with minimal expectations of finding anyone willing to align with our concept, we met the manager of a growing artisanal ice cream shop. The manager attentively listened to our collaboration proposal and expressed interest in the initiative. This interest led to bi-weekly dark matter and ice cream meetings, trials to develop a completely black ice cream without artificial colouring (in line with the company's policy), and an event that was repeated for two consecutive years, featuring scientific ice creams. Our part of the activity was to bring the scientific concept, and then have a short presentation on the release day of the ice cream. The remaining part, including the recipe for the ice cream, was left to the ice cream shop with total freedom. We tried to get feedback on our activity with a QR-linked simple questionnaire but got few feedback, all of which being very positive, probably biased by more pro-active persons.

As part of the broader science communication initiative of our group, not necessarily related to the Dark Matter Day, we were always needing some promotional items (t-shirts, mugs, pencils... something more traditional) that could reflect our research in science. We thought as a follow-up of the ice cream co-operation activity to look for people interested in producing these items (and selling them for their profit), while we would gain in communicating science from a dialogical perspective. We invited a group of local entrepreneurial women, the Colectivo de Diseño (Design Collective) to visit our laboratories, and entered in a horizontal dialogue process that recognises the area of expertise of each participant. They came with ideas for two projects: a dark matter puzzle (all black, with corners everywhere and other philosophical peculiarities) and bags with printed images corresponding to data taken from our dark matter detector on October 31 (the DM² project [6]). We expect both of these products to launch by the end of the year.

Our last co-production activity in this period was inviting a very young freelance artist to come every working day to our laboratory as an active part of the team for 15 days. We worked in an intensive way on a comics on dark matter. A teaser was presented at Tecnopolis, the largest science fair in Argentina, in July and August 2023, and the final 8 page comic was released on October 31 2023 (in Spanish) [7].

4. Public Perception

As already mentioned, an area in which we have always had difficulties is properly evaluating the impact of our activities. We decided to begin by assessing the situation before our activities, studying the public perception of dark matter, as a way to design a future public communication of a possible underground laboratory at the border between Argentina and Chile [8].

We started conducting these studies on the public perception of science with high school students asking them about their ideas, feelings, and understanding of the concepts surrounding dark matter, underground physics, and subterranean laboratories. Some preliminary results from a first study conducted in August 2023 indicate that the idea of an underground laboratory is associated with dangerous operation (explosions, viruses, bacteria, and highly secretive matters). This was a reasonably expected result. We were however pleasantly surprised to find that the majority of high school students knew about dark matter from social media and were familiar with it. When we informed them that dark matter has been searched without success for decades, they manifested that the search should continue. We plan on advancing with these studies to set the

ground for our (and others) future communication activities. It should help on one hand in having more significant experiences for the public, as their pre-conceptions can be taken into account when designing a communication initiative, and on the other hand in evaluating the impact of communication activities, comparing post-event public survey to their pre-conceptions.

5. Conclusions

Over the last 2 years, we developed a significant number of products in co-production with sectors not traditionally related to science and its communication. We found that people are eager to showcase and share their expertise with us, even if their areas are not scientific by nature. Our experience with shop owners, fan of games, local entrepreneurs, artists, among others, have allowed us to communicate dark matter with a level of professionalisation in the final product that our team could never even dream of achieving.

Further work is however needed to properly evaluate the impact of these activities. We started recently conducting public perception studies to evaluate the pre-conception ideas and feelings related to our field, and need to develop more attractive ways to get feedback on our activities, as we find the one we currently receive to be (positively) biased.

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