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Outreach activities have recently grown in importance with the specific goal of including and involving the non-expert community into the scientific world. The **Physics4Teenagers** outreach group of the University of Pavia Physics Department takes part in the effort of designing new ways to do so, in parallel with more canonical seminars and laboratory activities.



To this end, we designed the “PER me si va ne la fisica recente” educational Escape Room and proposed it as a **non-formal teaching method** for high-school students on various occasions through 2021 and 2022. Such an activity has been proposed in three different contexts:

- within the **National Genova Science Festival**, to more than one thousand people;
- within the “TenDaysPhysics4Teenagers” **summer school** at the Pavia Physics Department, aimed at fourth-year high-school students;
- in two scientific **high schools** near Pavia for at least two weeks, specifically aimed at the students of said schools.

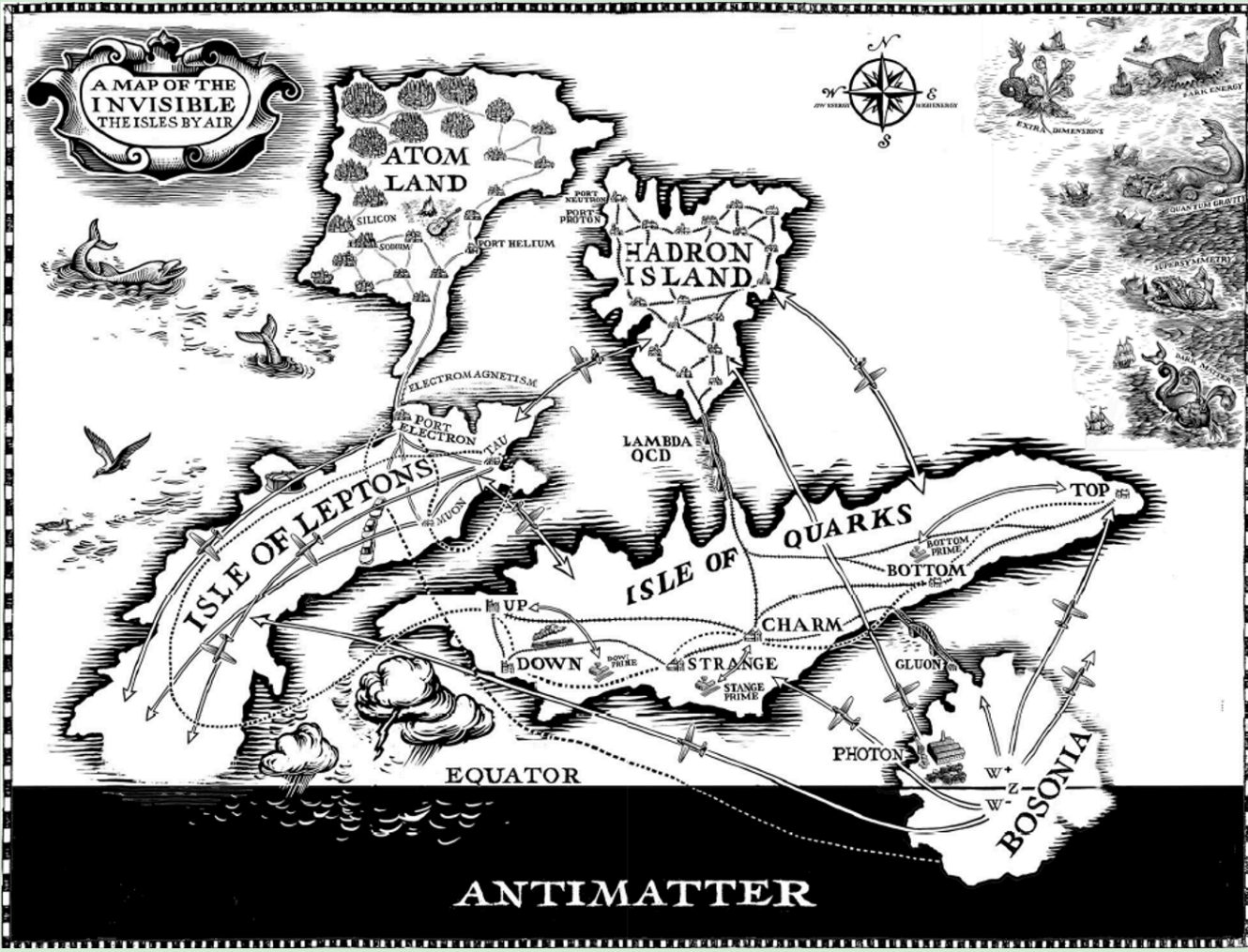
The idea of the escape room is to guide the students into building the Standard Model (SM) through a historical perspective: all the pieces of the “puzzle” are being gathered by the students through the reproduction of **famous experiments** or physical reasonings that led the physicists in history to make their discoveries. The journey starts with Democritus, with his atomistic idea. Democritus, performed by us, plays the role of Virgilio in the “Divina Commedia” guiding the audience through the most important steps of particle physics history in the first room.



- Among the most important historic steps, the following have been reproduced as puzzles for the participants:
- **Newton’s prism**;
 - discovery of **electric materials**;
 - **Rutherford experiment**;
 - **Chadwick experiment**;
 - **cosmic rays and antimatter** discovery;
 - internal structure of **hadrons**;
 - **Higgs’ mechanism** and Higgs’ boson.

By completing the SM puzzle the students are finally able to go beyond it. Democritus, unable to answer the questions left unsolved by the Standard Model, gives way to a modern and scientific version of Beatrice, the Curiosity, that in a second room tries to shed light on three open problems:

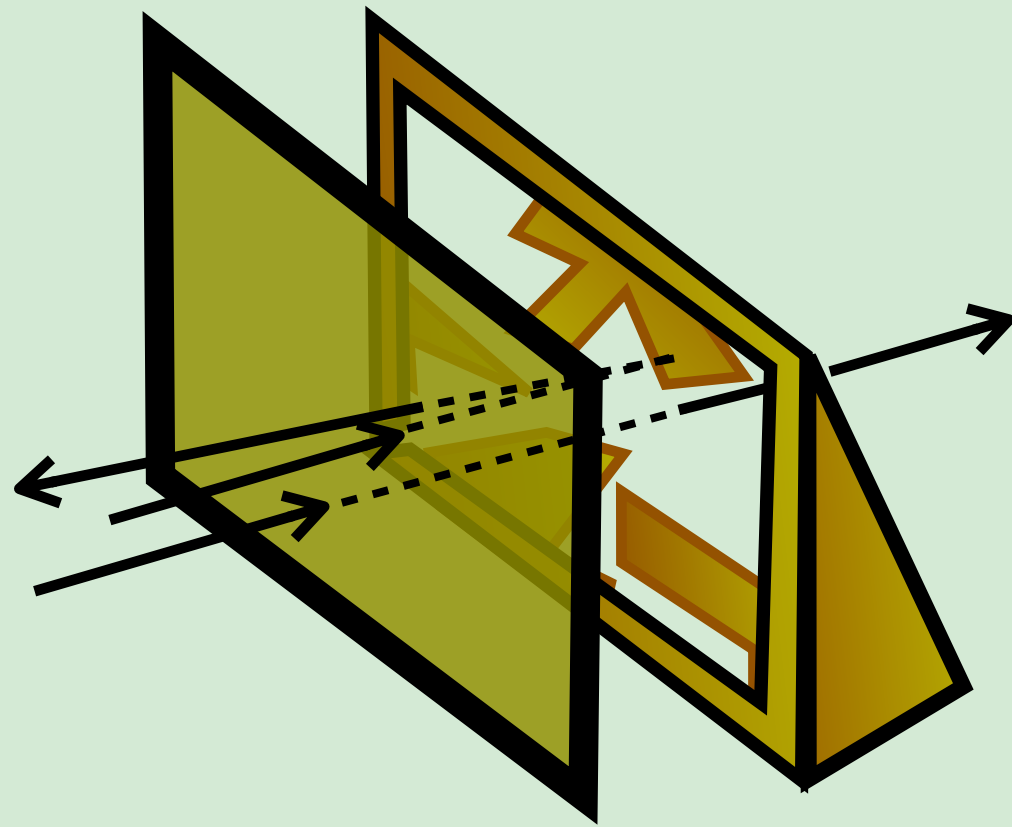
- **dark matter and dark energy**;
- **neutrino oscillations**;
- **gravitational force and graviton**.



Some of the **escape room puzzles**.

Rutherford experiment

Rutherford experiment has been reproduced macroscopically with **recycled** and **inexpensive material**. Basically, a wooden stand has been constructed, with unevenly-shaped wooden pieces arranged in casual positions inside the wooden frame. A sheet of glided tissue paper has been placed in front of the stand.



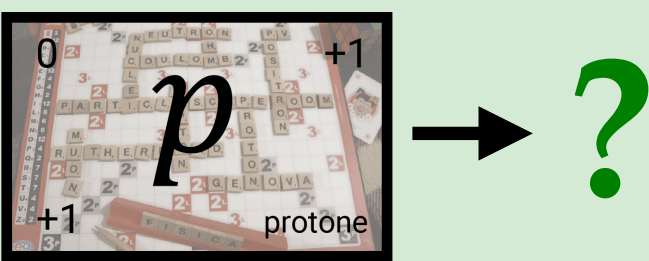
Participants, in the role of Rutherford, shoot alpha-particles (plastic bullets) at a gold foil (the glided tissue paper) with a particle accelerator (a toy gun) . The result of the experiment is that some alpha-particles pass through the gold foil, and others are bounced back. This implies the inappropriateness of the Thomson atomic model.

Cosmic rays and antimatter.

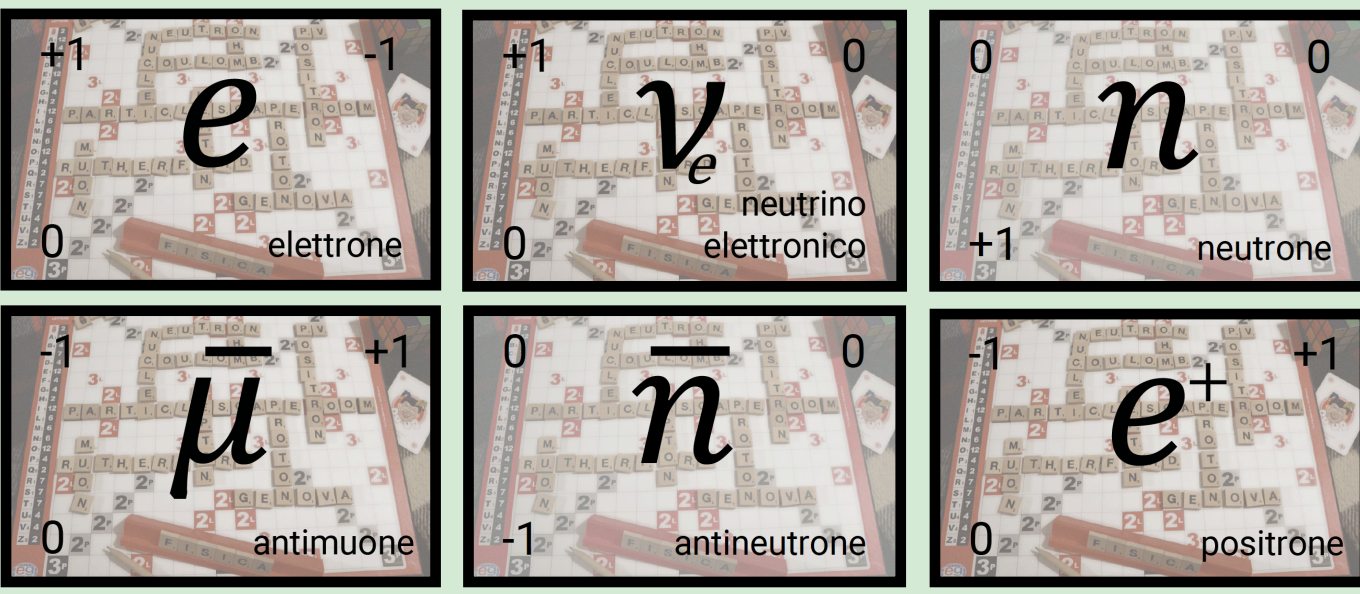
Charged particles are deflected by magnetic fields due to the Lorentz force. The radius of curvature is proportional to the mass of the charged particle. Participants can play with our **home-made console**, which permits to vary the magnetic field (versus and strength), the masses and the charges of the particles. By doing so, muons, pions and positrons are discovered by the audience.



Proton decay and neutrino existence



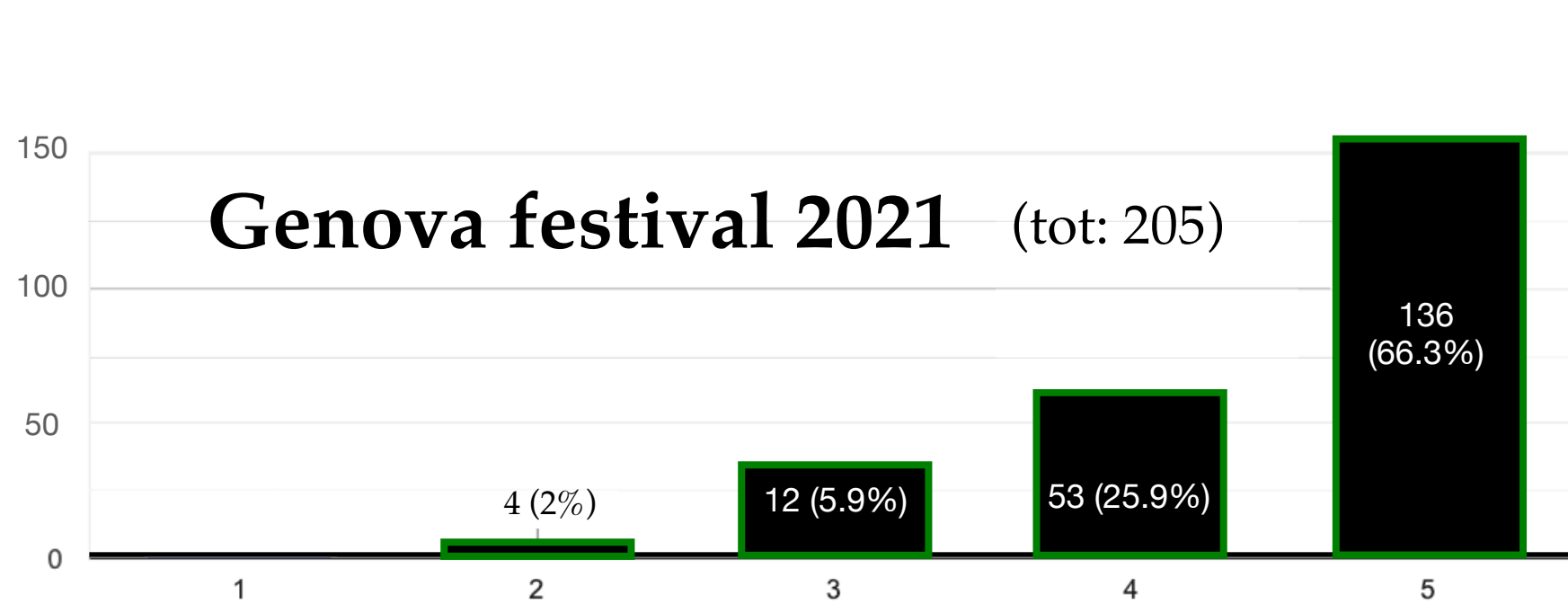
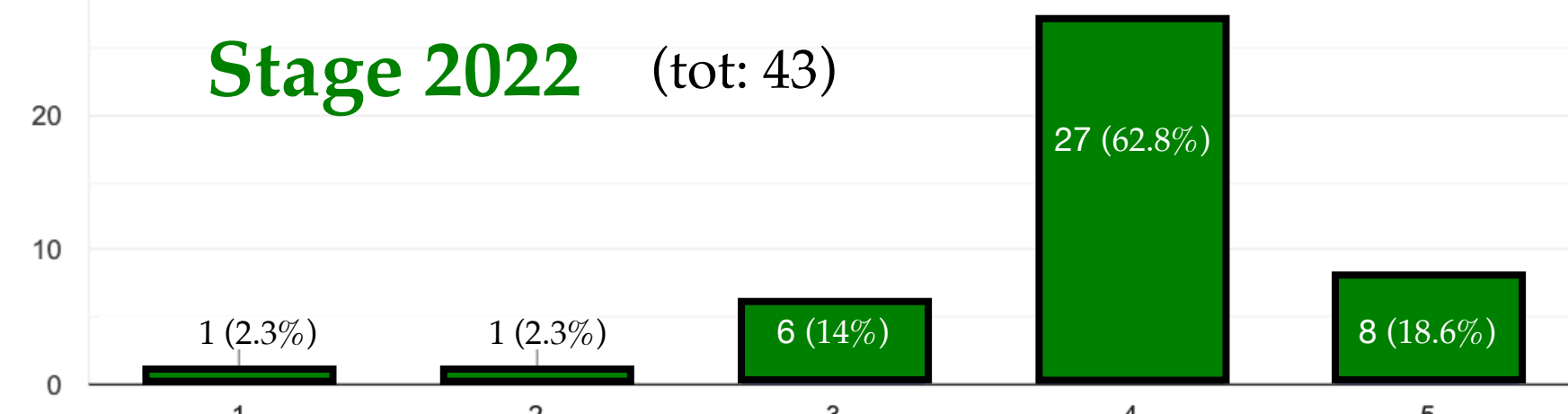
A question is asked to the audience: “which of the following particles are the products of the proton decay, given that charge, baryonic number and leptonic numbers have to be conserved?”. The answer leads to assume the existence of neutrinos.



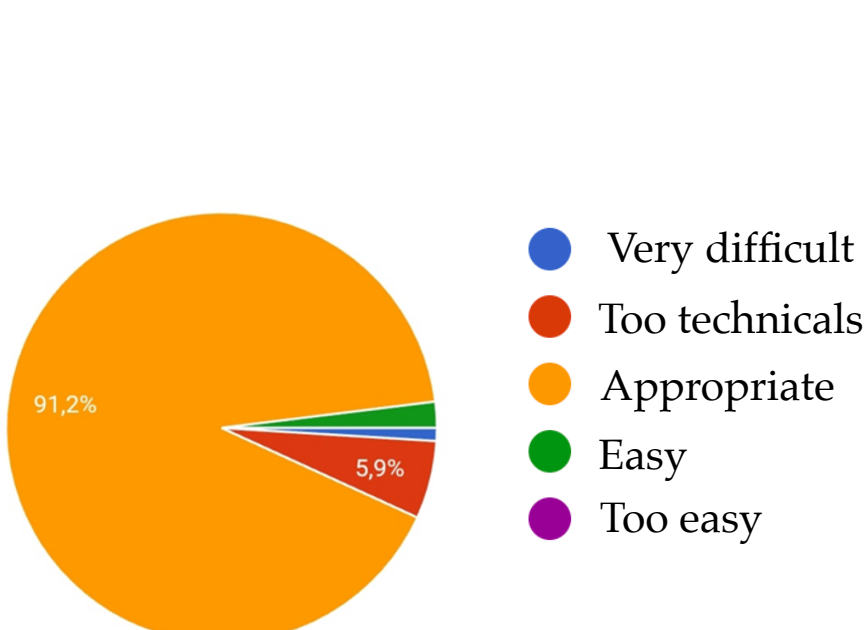
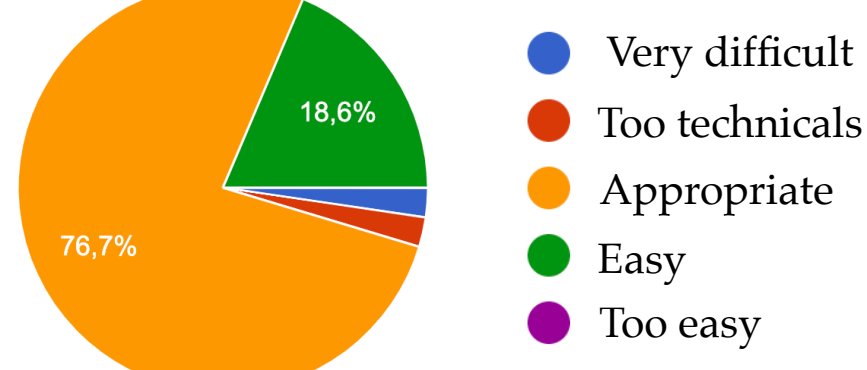
Results of the satisfaction questionnaire:

The participants were asked to complete a satisfaction questionnaire related to the escape room: the questions regarded how interesting and useful the activity was perceived by the participants. The results of the questionnaires for the Genova Science Festival and for the 2022 TenDaysPhysics4Teenagers summer school are shown in the tables below. As can be seen, the participants had an overall very positive opinion of the experience.

From 1 to 5, how would you evaluate the escape room experience?



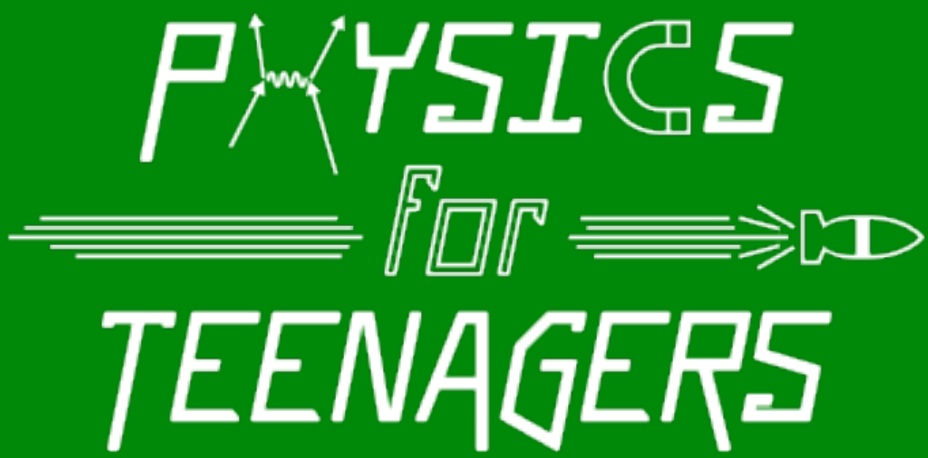
How were the topics covered?



We are planning to build also a **didactic effectiveness questionnaire** for the next preparation of the escape room with a pre-post physics test on the subjects that are discussed.



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