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Astronomy Festival “Colors of the Universe”

Castellaro Lagusello 19 – 20 June 2021

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The first edition of the Astronomy Festival, titled “Colors of the Universe”, took place in Castellaro Lagusello, near Mantova (Italy), on June 19 and 20, 2021. Castellaro Lagusello, ranked as one of the “Most beautiful villages in Italy”, for decades hosted a Buskers Festival that attracted thousands of visitors from nearby regions. For the first time Castellaro Lagusello has framed a scientific event. The theme of the Festival has been the electromagnetic spectrum and its use in astronomy. The goals of the Festival are multifold: promoting the dissemination of scientific culture and knowledge by engaging the public, linking the research institutes and universities with schools and the population by means of the so-called peer-education (i.e. PhD students are prepared by INAF researchers to educate high-school students who in turn lead the activities during the Festival, bringing them to the general public), and valuing the beauty of the territory and its historical sites. The Festival has been organized by Comune di Monzambano and INAF (main organizers: A. Zanella and F. Di Giacomo), and had the partnership of the European Southern Observatory and the International Astronomical Union. It included exhibitions, hands-on workshops, wall-map projections, outreach conferences, and observations with telescopes. The Festival reached about 4000 visitors, coming from all over North Italy, and it has received an excellent evaluation from the participants (2.9/3 overall). Given the success of the first edition, we are now organizing a second edition title “Attractive Universe” with gravity as a theme.

1. Events

The events at the Festival took place during the afternoon of Saturday June 19 and Sunday June 20, open-air, in the streets and squares of the city. Some private courtyards and the historical Villa Arrighi were open and made accessible to the public on this occasion. Tours of the protected naturalistic area surrounding the city were also organized by expert guides. In the following we described the scientific activities carried out during the Festival.

1.1 Exhibitions

At the main entrance of the city, the visitors encountered an exhibition made of 30 images of the sky observed with the telescopes of the European Southern Observatory (ESO). The exhibition was created to celebrate the 50 years of ESO’s activities; on the occasion of the Festival we re-printed it on suitable outdoor materials. The images were captioned in double language, Italian and English.

The visitors were also guided through the Festival by twelve panels with poems and prose texts with astronomical subjects. These included texts by: P. Salinas, C. L. Candiani, P. Cavalli, P. Neruda, I. Calvino, G. Rodari, M. Gualtieri, and D. Alighieri.

1.2 Hands-on activities

Eleven hands-on activities for kids and adults took place from 14:00 to 19:00 on Saturday and Sunday afternoon. These activities were designed by INAF astronomers and they were led by 55 high-school students from 5 different schools from the provinces of Mantova and Verona, previously trained by INAF astronomers. Each workshop focussed on a specific band of the electromagnetic spectrum (e.g. optical, radio, gamma rays, etc.) and used practical activities to let the participants pro-actively explore and understand astronomical phenomena. Each workshop lasted for about 45 minutes and had a maximum number of 15 participants. All material needed for the activity was provided to the participants. Figure 1 shows some pictures taken during the workshops.

The proposed workshops were:

- **Radioactive bananas and cosmic rays**

Brief description: Astronomers, to discover some of the most energetic phenomena in the Universe, use a specific component of light which is not directly visible with your eyes: gamma rays. During this workshop the participants experiment what objects of their daily life emit gamma rays (e.g. bananas, potatoes) and they measure such radiation with a Geiger counter. They also discover what astronomical phenomena can be studied thanks to such radiation and, by using LEDs and copper tape, they will reproduce one: a cosmic ray shower.

Minimum recommended age: 10 years old.

- **Chasing spectra**

Brief description: Thanks to light, astronomers investigate the origin of the Universe, the composition of stars, and many other mysteries of Cosmos. With this simple and fun activity the participants will discover some characteristics of optical light and build a spectroscope, a key instrument of astronomy. With the spectroscope the participants discover that different sources of light have different spectra and observe them. They also discover what emission lines are and how astronomers use them to infer the chemical composition of astronomical objects.

Minimum recommended age: 8 years old.
- **Catching starlight**

Brief description: For hundreds of years astronomers have used telescopes to observe the sky and uncover the mysteries of the Universe. The first telescopes were made with two lenses and could be lifted with a single hand. Today telescopes are made of mirrors and are huge. Despite their large dimensions, the physical principles underneath the optics of modern optical telescopes are the same that were used 400 years ago. During this workshop the participants discover what are the physical principles at the basis of optical telescopes, as well as the engineering and technological challenges that are met when building them. The participants create simple optical systems to produce various telescope models and can follow the light path through the optics.

Minimum recommended age: 8 years old.
- **Let's invent a planet!**

Brief description: Our Sun is a star as many others in the Universe and our Solar System turns around it. However, this is not the only planetary system in the Universe, and modern telescopes keep discovering new planets orbiting around many other stars, the so-called "exoplanets". Astronomers often know the physical properties of these planets, but they do not have a direct image. On the basis of the known characteristics, the participants are asked to imagine these extrasolar systems, the planets and their surfaces, and to draw them. All drawings are uploaded on the website of the Festival ([here](#)).

Minimum recommended age: 4 years old.
- **Are colors always the same?**

Brief description: Light and its colors are one of the main pieces of information we have about the Universe. To obtain the colorful images of the sky that we are used to seeing, telescopes are equipped with filters. During this workshop the participants build a filter wheel to understand how filters work and how they are used to obtain color images. They also understand how filters allow astronomers to obtain information about specific regions of astronomical objects and to investigate their physical properties.

Minimum recommended age: 6 years old.
- **Seeing the invisible**

Brief description: The infrared light emitted by stars passes through clouds as the optical light passes through glass. Some regions of the Universe are invisible to our eyes, but they become visible to astronomers that use infrared light for their observations. Cutting edge telescopes as the Very Large Telescope and in a few years the Extremely Large Telescope are optimized to observe infrared light. The participants to the workshop through an exhibit explore the properties of infrared and optical light, to understand that infrared light allows astronomers to study mysterious objects of the Universe, such as exoplanets. The participants, thanks to a termocamera also discover how infrared light is used in our daily lives.

Minimum recommended age: 6 years old.
- **Astronomical puzzle**

Brief description: Through telescopes, astronomers receive black and white images of the Universe. During this workshop the participants understand how the beautiful and colorful astronomical images we are used to seeing are obtained. Thanks to a game, by building puzzles, the participants discover that different wavelengths of light show us various regions of the sky and only by putting together all wavelengths we can have a complete picture of the Universe.

Minimum recommended age: 6 years old.



Figure 1: Pictures taken during the hands-on workshops. *Top left panel:* workshop “Are colors always the same?”. *Top right panel:* workshop “Radio-treasure hunt”. *Bottom left panel:* workshop “Radioactive bananas and cosmic rays”. *Bottom right panel:* workshop “Catching starlight”. Credit: Simona Frigo.

- **Microwave telescopes do not melt cheese**
 Brief description: Visible light that can be perceived by human eyes travels with constant speed. Microwaves are also part of the electromagnetic spectrum and therefore they also travel with constant speed, but we cannot see them directly. The participants of this workshop measure the speed of light using melting cheese and a microwave. They also discover how astronomers use microwave and radio telescopes, by building a paper model of the Sardinia Radio Telescope.
 Minimum recommended age: 8 years old.
- **Astronomical memory**
 Brief description: This activity is meant for the youngest. The participants play the game called “memory” by using cards printed with astronomical images. They have to find couples of cards with the same picture: nebulae, galaxies, telescopes, and many others. While playing, they are told some of the characteristics of the astronomical objects they are seeing and related anecdotes.
 Minimum recommended age: 4 years old.
- **Astronomical tales**
 Brief description: The Universe is fascinating for everyone. The participants listen to some astronomical tales, read and commented by astronomers. They can relax and leave their fantasy free to travel among words, images, and astronomical objects. This is also an alternative and emotional way to learn more about our Universe and to interact with professional astronomers.
 Suitable for all ages.



Figure 2: Picture taken during the conference “Colors of the stars: a spectroscopic workshop”. The picture was taken by a spectator through a grating that was provided to the public by the speaker, Paolo Ochner, to see the spectra of various lamps.

- **Radio-treasure hunt**

Brief description: Even if the participants do not see it, it is there: it is a radio transmitter that is only waiting to be found. But the transmitter is invisible not only because it is hidden, but also because our eyes are not sensitive to radio waves. The only way to find it is to detect the signals that it emits with a radio waves receiver. To do so, the participants use antennae, receivers, and detectors to understand where, around the city, the signal increases revealing the possible presence of the transmitter. They look for radio waves in a similar way as radio astronomers study the radio waves emitted by astronomical sources and understand the nature of our Universe.

Minimum recommended age: 3 years old.

Descriptions of the workshops (in Italian) can also be found [here](#).

1.3 Outreach seminars

Researchers and outreach experts of the Istituto Nazionale di Astrofisica (INAF) gave two outreach talks, on Saturday and Saturday evening, in the beautiful garden of Villa Arrighi.

- **Elements of the Universe: how stars created the periodic table**

Speakers: C. Boccato, E. Cappellaro, F. Di Giacomo, L. Greggio, S. Zaggia.

Brief description: Various versions of the periodic table are available online. The one designed by Jennifer Jahnsen from the Ohio University orders the different chemical elements based on their astronomical origin, showing a surprisingly different classification from other tables. Hydrogen, present in each water molecule, was generated during the Big Bang. Carbon and oxygen originated in the nuclear fusion process inside stars. The majority of iron is produced during the explosion of supernovae. The gold used for our jewelry could have been formed during neutron stars collisions, recently observed as powerful and short gamma flashes, confirmed by gravitational waves. Other elements, such as phosphorus and copper, which are crucial for the functioning of our body, have originated during the explosion of the most massive stars in our Universe. Five scientists, acting as narrators, discuss the astronomical origin of various chemical elements, as well as their abundance or rarity, and the role they have for the development of life and the formation of astronomical sources.

- **Colors of the stars: a spectroscopic workshop**

Speaker: P. Ochner

Brief description: How can astronomers get information about the stars through their colors? This conference-workshop allows the participants to understand how astronomers study stars through their spectrum. Various lamps that mimic different stars are used and participants are asked to observe them through special glasses whose lenses are equipped with diffraction gratings (400 lines/mm). The following topics are touched upon: functioning of lamps and stars, story of spectroscopy from the nineteenth century on, current applications of spectroscopic techniques (environment, medicine, etc.), light and vision. Figure 2 shows a picture taken during the conference.



Figure 3: Wall mapping projections. *Left panel:* facade of Villa Arrighi. *Right panel:* the bell tower of Castellaro Lagusello. Credit: Simona Frigo.

1.4 Shows

The physicist and juggler Federico Benuzzi told the visitors about physics with the show “The juggler of science”. The show was performed twice per day, both on Saturday and Sunday. It combines physics and jugglery, two subjects only apparently unrelated. F. Benuzzi highlights the links between these two words, alternating theatre monologues and technical exhibitions to let the public appreciate what it means to use the laws of physics to create something artistically beautiful.

1.5 Wall mapping projections

The medieval tower at the center of the city and the nineteenth-century Villa Arrighi were lightened up with astronomical images taken from the ESO observatories, plunging the visitors in an immersive astronomical setting. The projections were accompanied by music.

1.6 Telescope observations

On Saturday, the amateur astronomers from the Circolo Astrofili Veronesi brought telescopes to show to the visitors the Sun and the night sky of the summer solstice while telling them about the underlying science and myths. The Sun observations during the day were performed from one of the main squares of the city, while the night observations were carried out from one of the dark gardens of the Villa Arrighi, next to the moraine lake.

2. Engagement of high-school students and the local population

The main objective of the Astronomy Festival was the diffusion of scientific culture, research, and astronomical knowledge. To effectively achieve this goal, the organizers involved 55 students from high-schools of neighbouring cities (provinces of Mantova and Verona) with age 16 - 18 years old. On June 9th three astronomers of INAF (A. Zanella, F. Di Giacomo, and S. Ricciardi) taught the students how to facilitate the hands-on workshops (see Section 1) and the related astronomical concepts. The training took place in Verona, in two sessions (from 9:00 to 13:00 in the morning, and from 14:00 to 19:00 in the afternoon). Each student participated in one session and learned how to deliver a single workshop, for a total of 5 students learning how to lead each workshop. The students then delivered the workshops during the Festival, passing down their knowledge to the visitors (kids and adults). The schools officially recognized the training and activities carried out by the students (20 hours of “alternanza scuola-lavoro” under the PTCO agreement).

This approach has proven very effective for several reasons. First it allowed us to engage teenagers attending the last years of high-school, who in the following year have to decide what University to attend (if any), putting them in contact with actual researchers and giving them the opportunity to discover the astronomical culture, a subject that is often shortly discussed at school and often not even present in the curricula. The hands-on nature of the activities and the playful environment made it possible to also engage students that did not have a marked interest in the subject beforehand. Furthermore, the involvement of students as leaders of the activities during the Festival enabled the creation of a “peer-education context”, effective not only for the transmission of knowledge to younger kids, but also to create role models. Finally, after an entire school year during which the pandemic forced high-school students to attend lessons online, the Festival was the occasion to create a social network among them, even bridging students from different schools and provinces.



Figure 4: Poster used to advertise the Festival. The graphical project is by Francesca Zanella.

The Festival has also been the occasion to engage the local population and spread the astronomical culture in a rural area. The inhabitants participated not only as spectators to the Festival, but were also active players by opening private courtyards, usually inaccessible to the public, and setting them up to host the proposed activities. This created an atmosphere of empathy and support between the local population, the astronomers, and the students leading the hands-on workshops. This also allowed the locals to value the beauty of their territory, their historical and naturalistic sites, and to promote them among visitors coming from other cities.

3. Advertisement

The Festival was promoted on the local press, radio, and television. A press conference was organized on June 10th, in Mantova. There have been more than 15 articles published on newspapers and websites, two TV reports, and two radio broadcasts. A list of the published material can be found [here](#).

It was also advertised on social media. The advertisement campaign was organized by the city municipality and it included sharing news and short videos made by the Festival organizers and conference speakers, starting three weeks before the Festival. Pictures, news, and videos were also shared during the Festival and after it was concluded. The municipality also took care of the billposting of posters and delivery of fliers in key places (e.g. schools, bars, libraries, ...). The graphic design of the Festival (i.e. flyers, posters, information plaques, ...) were created by a professional designer (F. Zanella, Figure 4).

INAF astronomers (F. Di Giacomo and A. Zanella) realized two promotional videos, one targeting primary-schools and the other for secondary- and high-schools, that were sent to local schools. They also designed the website of the Festival: www.astronomiacastellaro.oapd.inaf.it

An email address (astronomiacastellaro@gmail.com) was created to answer the questions of the visitors.

4. Organization and collaborations

The Festival was created from the collaboration of the Municipality of Monzambano, local associations (Fondazione Città di Monzambano and Associazione Alda Merini), and INAF. The main organizers of the Festival were two INAF astronomers: A. Zanella and F. Di Giacomo. In addition, astronomers from the INAF observatories of Padova (C. Boccato), Bologna (R. Toniolo, S. Ricciardi), and Brera (S. Sandrelli) were directly involved in the organization.

The Festival also got the patronage of the International Astronomical Union and the collaboration of the European Southern Observatory. A complete list of collaborators and sponsors can be found [here](#).

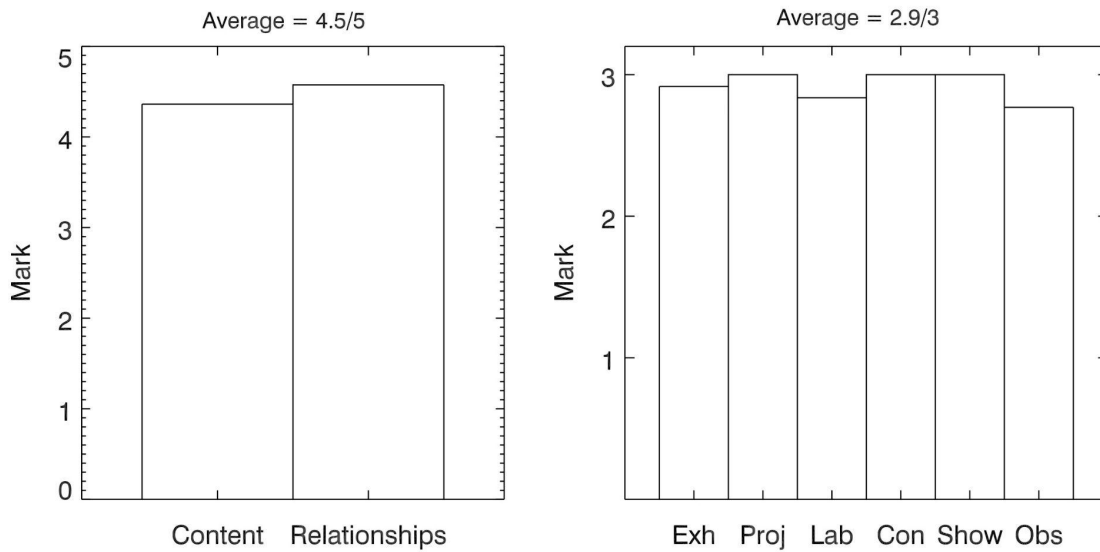


Figure 5: Statistics of the Festival evaluations. *Left panel:* evaluation given by the high-school students who delivered the workshops during the Festival. They were asked to evaluate the scientific content of the Festival and the relationships with the public, with the organizers, and among themselves, based on a scale of 5 marks: 1 = disappointing; 2 = unsatisfactory; 3 = mediocre; 4 = satisfactory; 5 = excellent. The average score is 4.5/5. *Right panel:* evaluation given by the visitors during the Festival. They were asked to evaluate the exhibition (Exh), the wall mapping projections (Proj), the hands-on laboratories (Lab), the conferences (Con), the shows (Show), and the telescope observations (Obs). They have been given a scale of 3 marks: 1 = disappointing; 2 = mediocre; 3 = excellent. The average grade is 2.9/3. Both questionnaires are reported in the Appendix.

5. Budget and economical contributions

The total cost of the Festival was 17,000 euros. The Municipality of Monzambano obtained local and regional funds from Regione Lombardia (2,500 euros), Banca Agricola Mantovana (5,000 euros) e TEA (3,000 euros). In addition, the Municipality of Monzambano gave 6,500 euros.

The budget was used to cover the costs of the material employed during the hands-on workshops (500 euros), printing advertisement material and information plaques (3,000 euros), printing the exhibition panels (1,000 euros), trip and accommodation costs of the conference speakers (1,000 euros), costs of actors for the show (1,000 euros), rental projectors and technical team for the wall mapping projections (5,000 euros), rental of conference hall, parking slots, security equipment (3,500 euros), photographic and video coverage prior and during the Festival (2,500).

The visitors had free access to all the events.

6. Impact and evaluation

During the Festival we monitored the number of visitors, their geographical provenance, and their appreciation of the proposed activities through evaluation questionnaires.

The Festival had a total of 4,000 visitors, of which about 1,500 participated in the hands-on workshops and about 150 per night participated in the outreach seminars. In particular the participation in the hands-on workshops and seminars was limited due to the capacity of the locations and the anti Covid-19 rules in place at the time.

Visitors arrived not only from neighboring cities, but also from the major cities in the North of Italy, more than 100 km away (e.g., Milano, Brescia, Padova, Treviso, Trento, Bologna, Firenze).

Visitors gave an overall excellent evaluation of the Festival (2.9/3, Figures A1 and A2). Even the high-school students who delivered the hands-on workshops evaluated the experience as “excellent” both for the content, the knowledge they learned, the organization of the activities, and the relationships they could build (Figure 5). In particular, during the training activity the organizers asked the students to answer with one or two words the following question “What do you expect from this experience?”. The answers were gathered in a “cloud of words”. The most repeated words were “knowledge”, “interest”, and “learning”. The organizers repeated the experiment at the end of the Festival, asking the participants “What did you get from this experience?”. Together with words related to “knowledge”, also terms related to “relationships” appeared, indicating that not only the training and the

Da questa esperienza mi aspetto



Da questa esperienza ho ottenuto



Figure 6: Word clouds obtained by asking the high-school students who delivered the workshops during the Festival. *Top panel:* word cloud obtained before the training “From this experience I expect...”. The most repeated words are “knowledge”, “interest”, and “learn”. *Bottom panel:* word cloud obtained at the end of the Festival “From this experience I have obtained...”. The most repeated words are “relationships”, “knowledge”, “fun”.

Festival achieved the goal to transmit astronomical contents, but it also helped to create a network between peers, a fundamental achievement in that age range and in this historical period (Figure 6).

The visitors’ turnout and liking has been fully satisfactory, especially considering that this was the first edition of the Festival and that the entrance to the events had a fixed number due to the anti-Covid19 regulation. The media coverage has been appropriate and satisfactory, too. The fact that high-school students have since then been emailing the organizers, asking whether they can enroll to deliver hands-on activities during the second edition of Festival, is highly encouraging. Visitors are also asking for information about the organization of a second edition.

7. Future editions

Given the satisfactory outcome of the first edition of the Festival, the organization of the second edition is now ongoing, with the idea that the Festival will become a yearly appointment. The second edition, titled “The attractive Universe” will be held in Castellaro Lagusello from the 10th to 12th of June 2022. The dates are set based on the visibility of the Moon in the first part of the night, a key requirement for the telescope observations. The Festival will start on Friday evening (June 10th) instead of Saturday afternoon, to ease the set-up of the Festival, have a more suitable time for the inauguration, and allow for one more outreach conference and one more night of telescope observations. For the second edition also the PhD students of the University of Padova (department of Physics and Astronomy) have been involved. Astronomers from INAF (A. Zanella, C. Boccato, S. Ricciardi, S. Sandrelli, and F. Di Giacomo) will train PhD students during the University course “Designing innovative public engagement techniques” that will be held at the University of Padova between February and April 2022. The PhD students will design and build the hands-on activities to be presented at the Festival. In this process they will learn how to effectively communicate their research to the general public in an innovative way. This is the only course about public engagement in astronomy that is offered at the University of Padova and therefore it has a key role in the professional development of the PhD students. Between April and June 2022 the PhD students, supported by INAF

astronomers, will train the high-school students who will in turn present the hands-on activities during the Festival, as already successfully experimented during the first edition.

Together with A. Zanella (INAF - Padova) and F. Di Giacomo (INAF - Padova), one more astronomer joined the organization team of the Festival, R. Toniolo (INAF - Bologna).

The subject of this second edition will be “gravity” and the format will be similar to the one proposed in 2021. Again, the turnout of the public and their liking will be evaluated, as well as the reaction of the media.

Appendix

A questionnaire was distributed to the high-school students who delivered the hands-on workshops during the Festival. They have been asked to evaluate the contents of the Festival and the relationships, based on a scale of 5 marks (Figure 7).

Also the visitors to the Festival were asked to grade individual activities (exhibition, wall map projections, hands-on workshops, conferences, shows, telescope observations), based on a scale of 3 grades (Figure 8).

Com'è stata l'esperienza dal punto di vista:

- **dei contenuti**

Eccellente Soddisfacente Mediocre Insoddisfacente Deludente

- **delle relazioni**

Eccellente Soddisfacente Mediocre Insoddisfacente Deludente

Commenti:

Figure 7: The questionnaire distributed to the students who facilitated the workshop.

A quali attività hai partecipato e come valuteresti l'esperienza?

• Mostra:	<input type="radio"/> Eccellente	<input type="radio"/> Mediocre	<input type="radio"/> Deludente
• Proiezioni:	<input type="radio"/> Eccellente	<input type="radio"/> Mediocre	<input type="radio"/> Deludente
• Laboratorio "Banane radioattive e raggi cosmici":	<input type="radio"/> Eccellente	<input type="radio"/> Mediocre	<input type="radio"/> Deludente
• Laboratorio "A caccia di spettri":	<input type="radio"/> Eccellente	<input type="radio"/> Mediocre	<input type="radio"/> Deludente
• Laboratorio "Acchiappare la luce delle stelle":	<input type="radio"/> Eccellente	<input type="radio"/> Mediocre	<input type="radio"/> Deludente
• Laboratorio "Inventiamoci un pianeta":	<input type="radio"/> Eccellente	<input type="radio"/> Mediocre	<input type="radio"/> Deludente
• Laboratorio "Ma i colori sono sempre uguali?":	<input type="radio"/> Eccellente	<input type="radio"/> Mediocre	<input type="radio"/> Deludente
• Laboratorio "Vedere l'invisibile":	<input type="radio"/> Eccellente	<input type="radio"/> Mediocre	<input type="radio"/> Deludente
• Laboratorio "Puzzle astronomico":	<input type="radio"/> Eccellente	<input type="radio"/> Mediocre	<input type="radio"/> Deludente
• Laboratorio "I telescopi a microonde...":	<input type="radio"/> Eccellente	<input type="radio"/> Mediocre	<input type="radio"/> Deludente
• Laboratorio "Memory astronomico":	<input type="radio"/> Eccellente	<input type="radio"/> Mediocre	<input type="radio"/> Deludente
• Laboratorio "Favole astronomiche":	<input type="radio"/> Eccellente	<input type="radio"/> Mediocre	<input type="radio"/> Deludente
• Caccia al radio tesoro:	<input type="radio"/> Eccellente	<input type="radio"/> Mediocre	<input type="radio"/> Deludente
• Conferenza "Elementi dell'Universo":	<input type="radio"/> Eccellente	<input type="radio"/> Mediocre	<input type="radio"/> Deludente
• Conferenza "I colori delle stelle":	<input type="radio"/> Eccellente	<input type="radio"/> Mediocre	<input type="radio"/> Deludente
• Spettacolo "Il giocoliere della scienza":	<input type="radio"/> Eccellente	<input type="radio"/> Mediocre	<input type="radio"/> Deludente
• Osservazioni del Sole:	<input type="radio"/> Eccellente	<input type="radio"/> Mediocre	<input type="radio"/> Deludente
• Osservazioni notturne:	<input type="radio"/> Eccellente	<input type="radio"/> Mediocre	<input type="radio"/> Deludente

Commenti:

Figure 8: The questionnaire distributed to the visitors.