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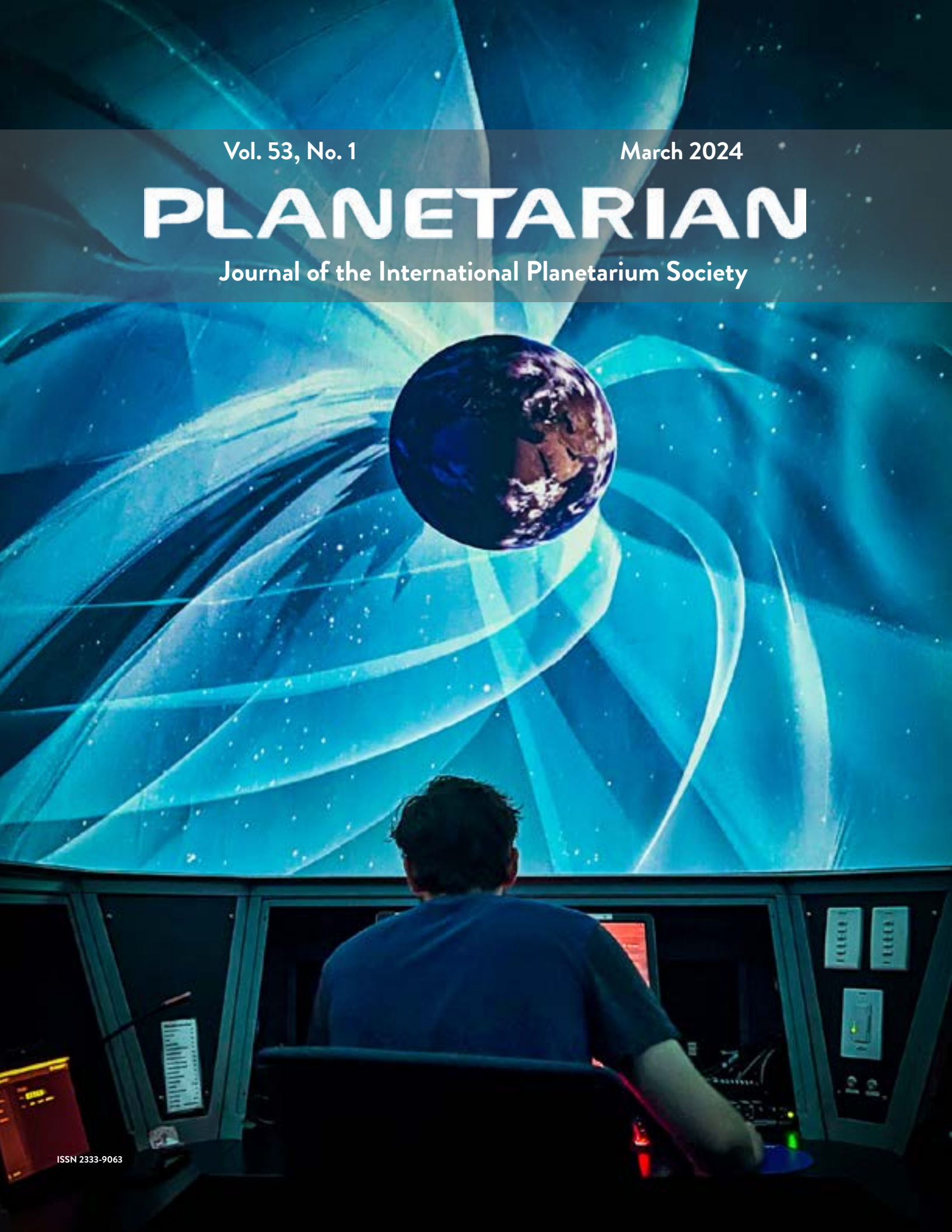

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IPS President Dave Weinrich
Welcome to the 2012
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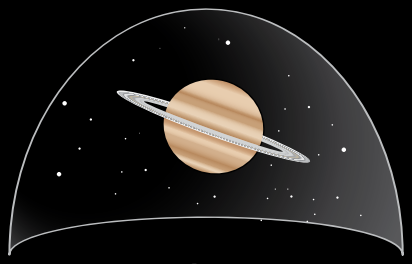

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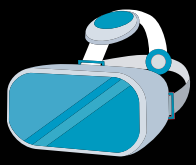

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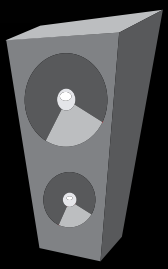

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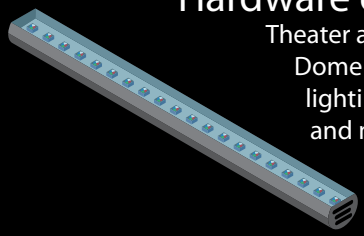

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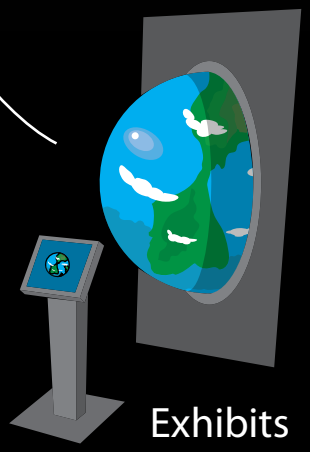

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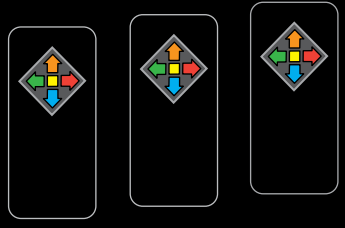

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A LOOK FORWARD
PRESIDENT'S MESSAGE

After six long years, this July we will meet together in one place, at one time, to celebrate our collective past, present, and future. I can't remember ever being as excited for a conference as I am for Jena and Berlin. These conferences are the culmination of years of hard work and preparation, and the work behind the scenes is magnitudes more than most of us will ever see. It's certainly true that the past few years have provided us with the technological resources to make the world feel smaller - to more easily see and hear one another over continents and oceans. But none of that can replace the feeling of community that comes from sharing the same rooms and domes with our peers and colleagues.

This year is also very important to the future of our organization as we choose the next slate of leaders in IPS. There is so much good that this organization has done, and will continue to do, but none of it is possible without dedicated and inspired leaders with a vision for a stronger, better IPS. It is that spark of inspiration that so many of us work from every day. For me, it's been the most eye-opening journey of learning how best to find that spark - and to ignite it in others.

I was deeply honored to give the Spitz/Noble keynote address at the "Stars For All" United States national conference last year. It took months (if not years, given the initial invitation in 2020) to come up with something meaningful to talk about. What sage words or philosophical insight could I possibly hope to give? I found I was most comfortable talking to myself - or at least, to my younger, less experienced, and less jaded self. I wish I had known that, like me, others felt they didn't belong. I wish I had known that speeches or leadership positions aren't finales to my story, simply chapters in an ongoing narrative.

Most importantly for me was the realization that my "legacy" (if there is such a thing) is not what I've done, but what I've done for others. It's knowing that in a year, I will no longer be president, because a dear friend and a remarkable planetarian in Shannon Schmoll will take my place and lead IPS. I can only hope that she will do this job better than me, because if not – what's the point? Why do any of this if it doesn't raise up the whole community?

I say all of this because we will need new leaders in positions worldwide. Some will be officers and board members. Some will represent our affiliate organizations with aplomb. Others will take over important roles in committees, or their software user community, or decide to host a conference. These are the decisions that will have lasting impacts on the future of who we are as a community, and what sparks of inspiration are ignited for those who will follow us.

I've often been asked why I got involved in the first place – what inspired me to take on this role, during the height of COVID, with such limited clarity as to what our futures held. I can say with no false humility that I don't see myself as special or uniquely qualified to hold this position. When Patty Seaton approached me in May 2020, there was no immediate "yes," no delusion that what I had to offer was any better or worse than what other incredible peers could provide for IPS. But as I've seen over and over again, it's sometimes being in the right place, at the right time, that makes progress possible.

The time is always right to do the right thing. The time is always right to serve. The time is always right to inspire. But there is also a right time to realize that our work is simply the foundation for the next right thing, and the next right thing, and the next right thing after that. Sometimes it really is as simple as just doing one thing, and another, and another. If you have felt led to participate, then do it! We welcome everyone with open arms. It is the diversity of backgrounds, languages, employment, and lived experiences that will fuel the expansion and relevancy of IPS.

I think there's one word that best describes this future: inspiring.

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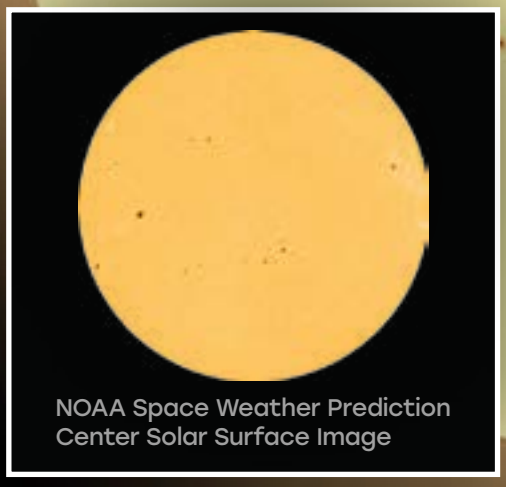

NOAA Space Weather Prediction Center Solar Surface Image

Solar Surface Rendered by Digistar 7

DIGISTAR 7

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FOR ALL THE THINGS
IN FRONT OF THE CONSOLE

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Between two eclipses, conferences, and more, it is a busy time for many planetarians as we all gear up for different events. Many of us are juggling a lot right now, so it is my hope that many of y'all are able to take a breather and make sure that you are taking care of your human domes as well as your regular domes.

Puns just write themselves, huh?

We here at Flandrau are preparing for the upcoming April eclipse (and crossing our fingers that April 8th will be one of Tucson's 286 days of sunshine). It should be an amazing view, even with 75% coverage. It is always so heartwarming to see people from all walks of life coming together on the University of Arizona's grassy mall to look up, together. We are also fortunate enough to be able to host one of our "Science at Sunset" programs the Saturday prior to be able to share the science of eclipses.

Have I mentioned how much I love "Science at Sunset"? To me, getting to host scientists from the University, having them share their cool research and getting to chat with public is such a great opportunity for everyone. Outreach is one of the most important pillars for science, and helping facilitate that outreach is an honor. I especially love watching kids get to ask questions - they have the best ones! Usually. Or at least the funniest. It reminds me of the meme where a kid at a planetarium show boos earth - I have seen it happen in real life, too!

Being in the position I am, I find myself spending time tinning about what it is that I want to do. What can I do to further help our mission, to share the love of space with others, to share the stories that make exploration exciting and part of everyone's lives? I think that is an existential question for some of us, as noted in last issue's transcript of Dan Tell's "Ghost Among the Stars" keynote for the Planetarium Centennial Launch. He spoke to the GLPA conference where they revisited Armand Spitz's quote "You may have heard me say many times that, in my opinion, the full potential of planetarium (and I use the word in its broadest possible connotation) has yet barely been scratched.". And how true those words ring, as it always seems there is more we can do! The reasons for sharing science are more than the pursuit of knowledge itself, but the sharing of the human spirit's need to know more of the cosmos we came from, how intertwined all our stories really are. I mean, don't get me wrong, LED domes and giant spheres are cool to look at - but if we can't inspire people to learn more, to have more open thoughts, and to come together under a common sky, then what purpose do we have? To that thought, Dan continued "The planetarium is a truly special machine, but it needs us to give it life. To bridge the connection between the individual and the cosmic."

It is truly special, and it needs special people to see its potential and share that with others - and maybe it's boastful to say that I think this group of planetarians are those special people.

While I have not had the honor to meet many of you in person, I have met many of you virtually over many zoom conferences (thanks Michael McConville!), and the ideas and passion that you all have is so inspiring. Even just recently, hearing all of the ideas about using the dome for speaking to climate change and the different methods everyone has - it's just great, and inspires me to do more.

Do I know what the more is? Not yet. Do I have ideas?

Always.

Normally I feel like I have more to ramble on about, but it's been a busy, busy start to 2024 at Flandrau. We are busy preparing for a swap to our exhibits, which has kept the exhibits director, facilities manager, and myself very busy. Why we decided to do three at once is beyond me - but we are committed, and we'll see how it goes.

We've also recently been able to upgrade our laser system to include Laser Fantasy's computer system. Laser shows have been a big hit for us recently, and Jay's subscription has allowed us to grow our library. Now only if I had more time to play with the software to build my own — maybe this summer.

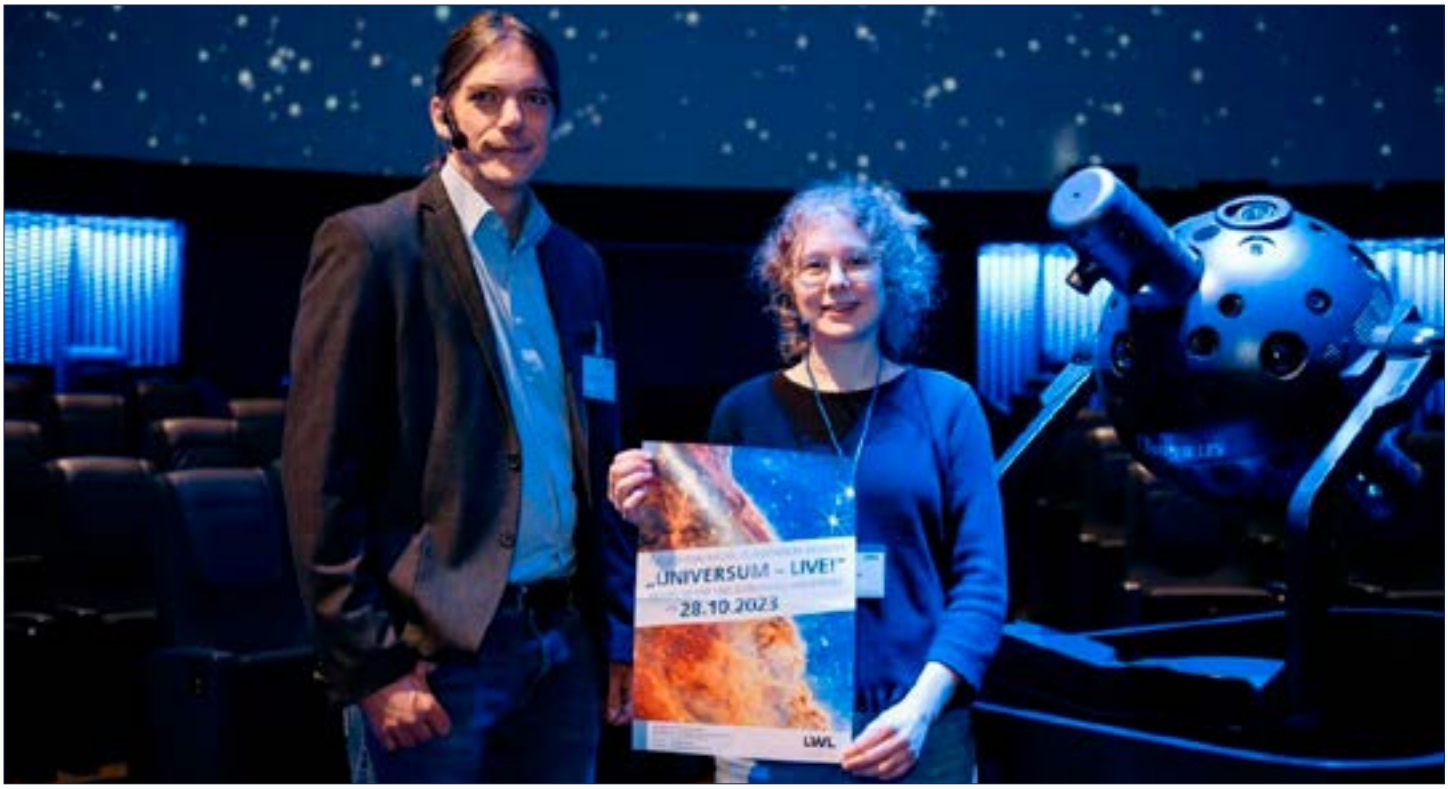
Lastly, we are beginning to prepare for our 50th anniversary. My collegue's passion for history has led him to newspaper articles that finally gave us our grand opening date — December 13th, 1975. It's an exciting prospect to get to do something big for this milestone, and once again I have many ideas, as I'm sure many of my teammates do. It is also fitting that the timing lines up with the 100th anniversary of the planetarium.

Exciting times are ahead, as always!

INTERVIEW WITH THE CREATOR OF UNIVERSUM-LIVE!

VOLUMETRIC 3D-MODELS IN INTERACTIVE PLANETARIUM SHOWS

By Wolfgang Steffen & Nico Koning, *ilumbra*



The astrophysicist Dr. Raffaela Busse (right), together with the planetarium director Dr. Tobias Jogler present the new show, Universum Live!. (Photo: LWL / Steinweg)

At the planetarium in Muenster, Germany, they recently started their new live, interactive show, *Universum-Live!*. Dr. Tobias Jogler is the director of the newly renovated planetarium and has more than a professional interest in high-energy astrophysical events. No wonder the show incorporates a volumetric 3D-model of the Crab Nebula (Messier 1), the famous supernova remnant.

Since volumetric 3D-models for interactive planetarium shows is our passion, we were curious about how Tobias and his team are using volumetric models in their show. In particular, we wondered how the audience responds to the models, if at all.

We would like to share this experience with our fellow planetarians and encourage them to let us know more about their own experiences with volumetric 3D-models in their live shows and what their audience has to say about them.

Wolfgang: Tobias, how would you summarize your new live, interactive show, *Universum-Live!* at the planetarium Münster?

Tobias: The show is a trip through the Universe for all audiences, regardless of their prior experience with astronomy. Starting on Earth and gazing at the starry sky above Münster, a well-trained presenter takes the audience on a live tour through the Universe. From the Earth to the ISS, through the solar system to exoplanets, and far beyond, audiences witness supernova explosions and their debris as well as black holes. It is a tour to the many natural wonders of our Universe.

Wolfgang: What motivated you to develop a new live show instead of licensing a pre-rendered show? Wouldn't that make your life much easier?

Tobias: We have many pre-rendered shows, and they are great. However, astronomy is a lively and

active field with new discoveries popping up all the time. We wanted to create a show that will be able to incorporate brand-new topics as quickly as possible. A pre-rendered show requires a time- and money-consuming process to include new scientific discoveries. In addition, we wanted to offer a more personal experience for our audience. Having an astronomy educator talking live to you about the universe while flying virtually through it is a completely different experience compared to a pre-recorded show.

Of course, having a live, narrated show requires much more training for the presenters and poses more stress on the computer hardware (using a real-time rendering engine compared to playing a video). In my opinion these "downsides" are not that important. We are very lucky to have highly educated and motivated presenters who easily learned the new show. We have also gotten very positive feedback from the audience so far.

Nico: Volumetric 3D-models are thought to be a heavy load on the computational resources of a digital planetarium, and running a live-show is already hard on the graphics cards. Why not simply feature some of the wonderful high-resolution 2D-images of the nebulae for *Universum-Live!* and ease the burden on the hardware?

Tobias: Many 2D-images are indeed stunning to the audience, but traveling through the object elevates the experience for every visitor. For most people, flying through the 3D-model makes the object much more real. For us astronomers, it makes it easier to explain certain features while we are passing them on our flight route. Luckily, today's hardware is powerful enough to show your 3D-models and allow fluid flights through them.

Nico: How much of a hit are the volumetric models on the performance of the system, say in terms of frames per second that can be displayed? Does the audience notice?

Tobias: We run them with our planetarium system and achieve 60 frames per second. We usually use slower flight speeds but mainly to not startle our audience. Up to now, we have not seen any stuttering, though the hardware goes up to 100% usage. Of course, one should not load multiple volumetric models at once or strain the system with additional heavy loads.

Wolfgang: Are there any other intrinsic drawbacks of volumetric models compared to surface mesh models that you are aware of?

Tobias: Not really. Surface mesh models are nice if you stay outside, but if you want to fly through them, they are not really an alternative to volumetric models and most astronomical objects are volumetric objects.

Wolfgang: Do presenters need special training to effectively incorporate volumetric 3D-models in their narrative?

Tobias: I would say no. At least, there were no more questions about the volumetric models compared to images or surface mesh models.

Nico: You decided to use the volumetric model of the Crab Nebula from *ilumbra*. Do supernovae play an important role in the show?

Tobias: Yes, they do. The show takes the visitors through the stages of stellar evolution. And, of course, the death of massive stars is an important part of this. Supernovae are fascinating, and their resulting remnants as well. Also, many people like to learn that most heavy elements (like gold) originate from such explosions.

Wolfgang: What would you like volumetric models of nebulae and galaxies to be like in interactive shows a few years into the future?

Tobias: It would be great to be able to have them even more refined, especially in the interesting regions. Flying through a detailed volumetric galaxy to experience the effect of dust and cold gas clouds on blocking out the stars would be great. For me, it is most important to have models that are firmly based on scientific measurements.

Wolfgang: What is the main audience of the new show?

Tobias: The show is for everyone age 8 and older. It does not require any prior knowledge of astronomy, but still, we visit some of the most interesting places in our Universe, like the Crab Nebula and Sgr A*, the black hole in the center of our galaxy. So even seasoned astronomers will find the show interesting and stunning.

Wolfgang: Lastly, what do you hope audiences take away from *Universum-Live!*?

Tobias: I hope they get an overview of our exciting and wonderful universe, and that they understand that what they experience in our show is not just pretty images but visualized, 'fresh off the presses' scientific results. Finally, I hope they get a perspective of us humans in the context of this vast and exciting universe.

Nico: Thank you for your time and for sharing your insights on your new planetarium show, *Universum-Live!*

MEDIA RECEPTION STUDIES IN THE PLANETARIUM

A HEADTRACKING STUDY INVESTIGATING THE RELATIONSHIP BETWEEN IMAGE COMPOSITION AND VISUAL ATTENTION

By Cora Braun, Kiel University of Applied Sciences & Europa-Universität Flensburg

Abstract

Since knowledge transfer is a key concept for most fulldome content, we should know how the content is received and processed by recipients in immersive environments to create knowledge growth. The objective of this research project is to investigate the relationship between image composition (unidirectional and omnidirectional) and visual attention of a recipient in a planetarium.

This empirical study uses an embedded mixed methods design with an observation measuring visual attention by tracking head movements and a questionnaire. The observation is conducted with the help of a self-developed Unity application using an HTC Vive Tracker 3.0 attached to the viewer's head. This experimental test setup examined the reception and memory of 10 test subjects viewing a 4-minute fulldome sequence containing both image composition approaches of interest.

The results show that the image composition impacts the visual attention of recipients: The more omnidirectional the image composition approach in the planetarium, the higher the activity level in terms of head movements and vice versa. Visual stimuli in a 360° environment in each dome sector can be perceived and remembered as stimuli by the recipients.

Thus, the image composition approach influences the visitors´ behavior and determines how much they move to adequately perceive the content. Unidirectional content hardly provokes any head or body movements and the visitor´s experience is therefore similarly passive (in terms of physical movement) to the reception of framed cinema content. In this study, omnidirectional content led to test subjects doing more physical movements (by looking and turning around) - the reception situation is therefore significantly more active and differs from that of conventional framed mass media.

Introduction and basic considerations

Planetariums and other domed environments serve as educational institutions by visualizing and teaching complex scientific topics, especially targeting astronomy-related issues. Learning successes are based on complex cognitive processes, but above all, content that is to be taught must be received as a stimulus by recipients first; otherwise, no information will make it into the cognitive apparatus and, therefore, cannot be processed, stored, or retrieved as information (Lang 2000).

From the media and communication studies perspective, research in 360° domes has focused primarily on long-term media effects, particularly on knowledge acquisition and corresponding didactic concepts to strengthen the planetarium as an educational institution further.[1] Less attention has been paid to media reception and the information-processing processes that precede long-term effects such as knowledge growth.

Compared to framed mass media, such as cinema, the projection surface of the planetarium is many times larger (Yu, Neafus, and Wyatt 2016, 28), and thus covers significantly more of the recipient's field of vision. However, the recipient can only see a partial area of the screen and not the entire projection surface at once. It is precisely for this reason that more physical movement of the visitors during the reception of fulldome content is possible, and potentially even necessary, to be able to receive the 360° content adequately. This fact becomes even clearer if we compare the reception situation in the planetarium with those of well-known framed mass media such as television or cinema. It is conceivable that the reception situation in the planetarium will be considerably more active than in the cinema, for example, since stimuli can potentially appear in a significantly larger area on the 360° surface. To perceive stimuli in 360°-

1 For an overview of various research projects on this topic see Yu (2023).

domed environments, head movements and possibly even upper-body movements would be required in addition to eye movements. However, physical activity during reception is not a binary state but rather a spectrum, at the ends of which are a lot of physical movement (active reception) and no physical movement at all other than eye movement (passive reception). At present, due to a lack of research, it is unclear whether recipients move at all in a planetarium, and if so, how much they move and what impact this has on the overall reception and information-processing processes. Therefore, in addition to long-term media effects, short-term media effects and information-processing processes that can be observed directly during or immediately after reception are even more relevant for gaining a deeper understanding of the fulldome medium. As a starting point, this paper will investigate how the image composition approach in the planetarium influences the visual attention of a recipient.

In the following, basic considerations on image composition approaches in the planetarium are undertaken and the fundamentals of visual attention in relation to the reception situation in the planetarium are highlighted to design an empirical study that investigates the research question.

Basic considerations: Theater layouts and image composition approaches

The planetarium institution, in general, but especially the reception space itself (the architecture of the planetarium interior, the auditorium), is not standardized. The planning of planetariums is a very individual process (Lantz 2020, 316-332); as a result, not only does the visitor has a different angle of view of the dome within one planetarium depending on where they are seated at the auditorium, but additionally, each institution again has an individual floor plan, and visitors will find even more configurations for the interior of a planetarium.

Here again, a spectrum with two poles can be defined, in which, between two extremes of planetarium architecture, a large area with various mixed forms emerges. On one side of the spectrum, there are planetariums that follow the architecture of a traditional planetarium as it was first presented to the public almost 100 years ago. For this traditional planetarium layout, a horizontally oriented dome with circular seating is distinctive (see Figure 1a). On the other side of this spectrum, there are planetariums with an architecture much more similar to that of a movie theater: here, the circular seating gives way to a staggered arrangement of directional rows of seats under a hemisphere inclined up to 30° (see Figure 1 b).[2]

This spectrum of architectural forms has historically evolved from the convergence of two formerly separate media spaces[3], culminating in the construction of the Fleet Space Theater in San Diego, CA, in 1973 (Marché 2005, 171). Here, not only is IMAX film technology output in a

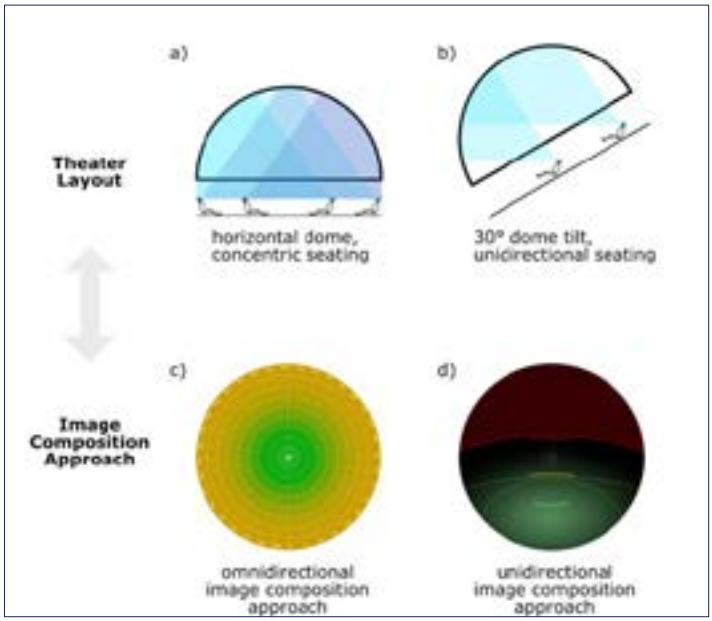


Figure 1: Schematic illustration of two major planetarium theater layouts (a and b: own illustration based on Lantz 2020, 320) and their corresponding visibility grids, which in turn dictate where important elements should be placed on the dome and thereby create their own image composition approach. (c: own illustration; d: Yu et al. 2016, 30).

dome-filling form for the first time (Marché 2005, 171), but traditional planetarium content continues to be used with a star projector and other additional projection devices (Anderson [1973] 2022). To combine both media (film and planetarium), the layouts of the two media are combined to create a new hybrid form. The combination of giant screen cinema with the planetarium thus forms the counterpart on the spectrum of planetarium architectures to the traditional planetarium layout. At this point, it is important to note that with the emergence of planetariums with directional seating, some of which also have a tilted dome, the traditional architecture of the planetarium has not disappeared but continues to exist in parallel. Today, both architectural types and their hybrids are still present in the planetarium landscape (Audeon and Ruiz 2023; Society of German-speaking Planetariums 2023).

These diverse architectural layouts of the planetarium auditorium create disparate perceptional arrangements for the reception situation, as the visitor is always positioned at a different angle to the dome surface and therefore sees different areas of the dome projection. The arrangement of the audience in relation to the dome surface determines to what extent the individual focal points of the recipients concentrate in a common shared sweet spot in one sub-area of the dome or how widely they are scattered over the entire 360° dome. This concentration or scattering of individual focal points can be visually outlined in so-called visibility grids. These domemasters visualize which areas of the dome are easily visible to visitors and which areas are less visible.

For directional seated and inclined domes, reference is made to the visibility grid created in 2007 by Yu, Neafus, and Wyatt (2016, 30) for professional practice (see Figure 1

2 These two main theater layouts are addressed in a wide variety of works, e.g. Lantz 2020; Yu, Neafus, and Wyatt 2016; Rienow 2013; Marché 2005.

3 The planetarium and the cinema, especially giant screen cinema.

d). According to their visibility grid, all objects placed in the green area are clearly visible to all visitors in the 25° tilted Gates Planetarium in Denver; additional head movement would be required for all content placed in the red area (Yu, Neafus, and Wyatt 2016, 30).

Since no visibility grid existed for domes with a traditional layout, one was developed within the scope of this research project (see Figure 1 c). The areas in the grid result from the concentric architecture within a horizontal dome: the area that can be seen equally well by all viewers is at the zenith (green area). The yellow highlighted area around the horizon is difficult to classify. For a visitor, one part of the yellow highlighted horizon is the area that is one of the best visible areas - but for a person sitting opposite to them, this area is the one that is least visible.

The theater layout and the resulting visibility grids are also reflected in different image composition approaches for fulldome content. In line with the concentration or scattering of the individual focus points of the recipients, there is fulldome content that places their plot-bearing elements in one part of the dome master and pursues a unidirectional image composition (as seen in Figure 1 d) or content that tries to distribute the plot-bearing elements as evenly as possible in all dome sectors to implement an omnidirectional image composition (as seen in Figure 1 c). As a consequence of this, the arrangement of the action-bearing elements on the dome demands a different degree of active reception from the recipients in a planetarium: in the case of an omnidirectional image composition, head movements and possibly even movements of the upper body are necessary in addition to eye movements in order to be able to receive the content adequately. In contrast, a unidirectional image composition does not require any further movements besides eye movements to be able to follow the content adequately. This mode of reception is thus much closer to a cinema reception than the omnidirectional image composition approach. (Braun 2021, 50–79; Rienow 2009)

The existence of these two different image composition approaches can not only be derived from the dome architecture but can also be found in practice. For example, the Fulldome Database www.fddb.org categorizes uploaded fulldome content into different categories, one of which is “Orientation”, which in turn classifies content into “unidirectional” and “panoramic” image composition approaches (Tiveron 2023).

These image composition approaches each fit one of the ends in the architectural spectrum outlined earlier. However, in practice, content is shown in a wide variety of architectural types regardless of its image composition, although there is evidence that image compositions are interchangeable only to a limited extent since they decisively influence the apparent media reception situation: planetariums with concentric seating and horizontal domes only sell parts of their seating capacity for certain shows. For example, in the case of unidirectional shows, only about two thirds of the seats are made available to be sold in the Mediendom at Kiel University of Applied Sciences (Mediendom 2023). Comparable patterns can be seen in other planetariums with concentric seating arrangements (e.g. Robert J. Novins Planetarium 2023). This is, first and foremost, less economical. Therefore, it can be assumed that there is a specific reason which affects the reception situation of visitors to the extent that institutions forgo parts of their potential revenue. However, there is no evidence that the operating costs for a unidirectional show would be lower compared to omnidirectional shows, which would allow a full seating capacity in domes with concentric seating arrangements.

Summarizing the previous findings; two different planetarium theater layouts emerge that create contrasting perceptual arrangements, which in turn are reflected in the image composition approach of fulldome content. It is reasonable to assume that these have an important influence on the reception situation for visitors in planetariums. To put it in hypothetical terms: (H1) The more omnidirectional the image composition in the planetarium is, the higher the activity level of a recipient. (H2) The more unidirectional the image composition in the planetarium, the lower the activity level of a recipient. These relationships are to be investigated in the following study.

Basic Considerations: Visual Attention

In the following section, the basic concepts regarding the second part of the research question will be addressed to be able to empirically investigate visual attention in the context of a media reception situation in the planetarium.

Visual attention can ultimately be understood as the interaction of the psychophysiological foundations of the eye and the human cognitive apparatus to perceive our environment (McMains and Kastner 2009, 4296–4302).

As presented by Lang (2000), humans have limited cognitive resources to perceive their environment. Information is perceived via the sensory system, processed in the cognitive system and, if necessary, retrieved later, for example to react to a stimulus. All three sub-processes share the same cognitive memory, i.e. if one of the processes uses more, less is available for the other processes. Due to this resource limitation, humans can only perceive part of our surroundings at any time. Information that has not been perceived cannot be processed. (Lang 2000, 47; Bojko 2013, 10–12).

It can be assumed that the direction of the gaze provides conclusions about which area is currently receiving visual attention and is thus potentially processed further in the cognitive apparatus (Müller and Krummenacher 2006, 122; Duchowski 2017, 3; Geise and Schumacher 2018, 362–63). Thus, if the influence of image composition on visual attention in the planetarium is to be investigated, above all it must be observed which part of the dome the recipients look at (and which areas, conversely, do not receive visual attention).

Basically, visual perception can only take place within the visual field. Stimuli outside this area cannot be perceived visually (Smythies 1996, 396-371). However, the human eye

can only see sharply within a range of approx. 2° (fovea); in order to perceive the environment, the eye must therefore jump from stimulus to stimulus within milliseconds, which means that the eye scans through space in saccadic movements (Bojko 2013, 10–12). Stimuli can be fixed within the visual field of fixation. In everyday life, however, a much smaller area of the field of fixation is often used – the field of use (Noorden and Campos 2002, 80). The field of use has a radius of approx. 10°; objects within this aperture angle of about 20° are mostly detected with eye movements alone, while objects outside the 20° aperture angle are detected via the use of additionally head movements (Eysel 2019, 783; Fischer 1924).[4] The perception of the environment in everyday life thus takes place – depending on the position of the target stimulus within the visual field – in part, or even primarily, via head movements (Eysel 2010, 379; Fischer 1924, 49).

However, the use of eye-tracking technology, which in theory could provide more detailed results than head tracking only (Geise and Schumacher 2018, 369), cannot be used in a planetarium without massive distortion of the natural reception process, mainly for technical reasons. Eye tracking is unreliable in environments that are too dark since the dilated pupils cannot be tracked as well. In addition, many mobile eye tracking systems, such as the Tobii Pro Glasses 2, cannot evaluate 360° film recordings, but only apply their evaluations to flat images.

At this point, it should also be noted that there are some eye-tracking setups in domes, for example in the ICG Dome at the TU Braunschweig. However, both installed systems in the ICG Dome only work under certain conditions (Grogorick et al. 2019, 1782) and can thus be classified as unsuitable for the test setup required here, as the aim here is to find out how much people look around the planetarium and how the movement relates to the positioning of the visual stimuli in the dome. The systems lose the eyes from the tracking area if the head movements are too strong and therefore cannot provide reliable results for this test setup. At this point, reference should also be made to experiments by Potęga vel Żabik, Bielecki, and Gochna (2016) in which mass measurements of eye tracking were carried out at the Copernicus Science Centre in Warsaw with the help of a dome grid and a corresponding paper-and-pencil self-assessment by the recipients. The fulldome content was interrupted at regular intervals by the eye tracking measurement grid, however, which distorted the natural reception of fulldome content in an everyday show setup. Therefore, these existing eye tracking concepts cannot be applied to this research question.

Since the environment to be studied covers 360° horizontally and 180° vertically and since humans tend to support eye movements with head movements if objects with high saliency lie outside of a 20° aperture angle (Eysel 2019, 784), it is even more likely that the test subjects in a planetarium will also make greater use of head movements than in other everyday life environments. For these reasons, this study uses not eye movements, but the next larger unit of perception – head movements – as an indicator for the investigation of visual attention.

Since the observation of head movements in combination with hypothetical assumptions about the field of view alone only allows a statement about which stimuli could potentially have received visual attention but does not allow a statement about whether these stimuli were actually perceived, successfully processed, and retrieved, a second method will be used. Therefore, in addition to observing head movements, a questionnaire will be handed out to the test subjects immediately after the fulldome reception situation to query their recall of various key stimuli. According to the Limited Capacity Model of Mediated Message Processing a memory of a stimulus can be understood as a reliable indicator that a piece of information has been successfully perceived, processed, and also retrieved within the human cognitive system (Lang 2000, 50).

Furthermore, information can be retrieved in two different modes:

1. as an object-based memory: Here, a recipient remembers primarily the content of the stimulus itself, for example, a fox in the constellation Vupecula.
2. as a spatial memory: In this case, a recipient primarily remembers the position of the stimulus relative to themself or other objects in space. In the planetarium context, for example, this would be a memory of something appearing in the starry sky to the recipient's right, but the person remembers only the position and not the object itself. (Mehta 2015, 1262–66)

The questionnaire therefore captures spatial and object memory to find out whether stimuli that were viewed were also successfully processed in the cognitive apparatus and does not examine long-term effects such as knowledge growth. The recall of a stimulus from short-term memory is thus used in the following as an indicator for reliably confirming that visual attention was paid to a stimulus (Bilandzic 2015, 12; Lang 2000, 50). Consequently, to investigate visual attention in the planetarium, this study uses a combination of head movement observation in conjunction with a questionnaire.

Method and Implementation

As already mentioned in the research question, the influence of unidirectional and omnidirectional full-dome content on visual attention was measured in the following. As pointed out in the last section, this empirical study used an embedded mixed methods design with a qualitative observation measuring visual attention and a quantitative questionnaire. The mixed methods approach aims to gain greater knowledge and an extended interpretation of the data since two complementary methods are used here (Creswell 2015, 19): Head tracking was used to generate objective observation data that allows initial tendencies for evaluation. The survey then supplemented these with subjective impressions and could then specify the statements of the head

4 This eye-head movement threshold will also be visualized in the observation software, to give an indication of where the eyes are most likely to be.

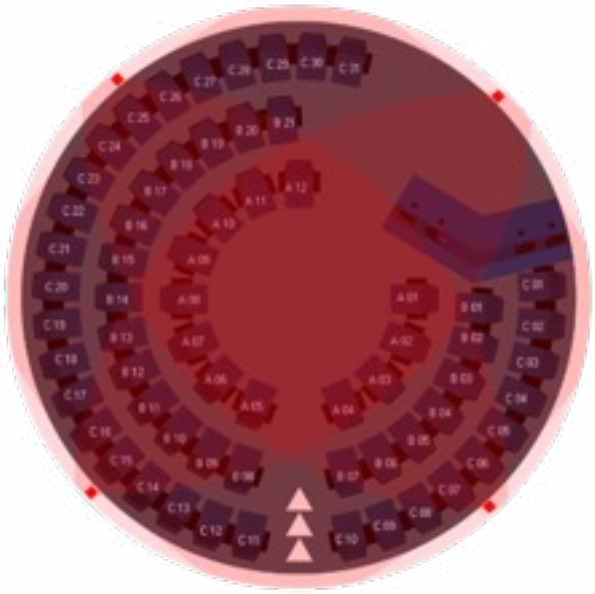


Figure 2: Schematic illustration of the arrangement of the lighthouse base station tracking system from HTC inside the planetarium auditorium. Each seat is covered by at least two base stations; therefore, reliable tracking within the whole auditorium is possible. (Own illustration)

tracking. Even if quantifying elements are collected by means of headtracking, the use of this method in this research design is qualitative, as the observation of head movement is primarily designed to obtain initial indications of movement patterns of a small group of test subjects in the planetarium.

However, for research economic reasons, only one of the two main planetarium theater layouts is chosen as the test environment for the study.[5] The Mediendom of the Kiel University of Applied Sciences was used as the test environment. This planetarium has a 9m horizontal dome and a fully concentric seating arrangement with 64 seats.

The observation of the head movement was conducted with the help of a self-developed Unity application using the tracking system of the HTC Vive lighthouse base stations 2.0, a VR headset[6], and an HTC Vive tracker 3.0. The four lighthouses were placed in the niches of the Mediendom at an angle of 90° to each other (see Figure 2). With this setup, the entire auditorium of the Planetarium can be tracked. The HTC tracker 3.0 was attached to the viewer's head with a head strap and a corresponding screw, allowing rotational adjustment in 3 Degrees of Freedom (see Figure 3). The corresponding Unity application (developed with the 2019.4.9 LTS Version) used the SteamVR Plugin to receive and process the tracking data. According to Bauer et al., "SteamVR is a black box" (Bauer, Lienhart, and Jost 2021, 1622) – measurement tolerances and deviations can only be estimated, but the HTC tracker seems to reach an accuracy within 0.68 ± 0.32 cm [centimeters] in position and 1.64 ± 0.18° in rotation (van der Veen et al. 2019, 3631).[7] However, these are negligible in terms of their effect on the results, as the evaluation of the head movements in this study is not specified in degree, but the movements are evaluated in a total of 5 sector fields on the dome, each covering 90° by 60° of the dome (see dome sectors in Figure 5).

Figure 3: Schematic illustration of the head tracking hardware: An HTC Vive tracker 3.0 is attached to a viewer's head with a head strap. A screw allows you to adjust the orientation of the tracker. (Own illustration)

The Unity application consisted of a true-to-scale 3D model of the Mediendom theater layout and a virtual representation of the tracker, from which light cones represent the two fields of view of interest. For the field of view, a size of 120° x 94° (Noorden and Campos 2002, 80) is assumed; for simplified representation, this field of view is extended to 120° x 120° in the application. The second light cone represents the 20° eye-head movement threshold, which is the threshold at which eye movements are additionally supported by head movements. No other light sources than the field-of-view-light-cones were used to illuminate the virtual scene. The entire scene was then filmed from below by a camera in Unity to create a dome view. To make the head movements visually interpretable and quantifiable, a raycast measures the position between the virtual tracker and the virtual dome (see red line in Figure 4). These data are mapped in spherical coordinates in the interface and additionally stored in a log file with a timecode. Since measurement inaccuracies can occur, as already described in Bauer et al. (2021, 1622), the system was set to the coordinate origin here with the help of a parent object in Unity. In the second calibration step, the distance between tracker and eyes was measured and entered in the UI, to relocate the raycast and the light cones.

The questionnaire consisted of 34 questions, of which 22 questions were compulsory and 12 questions were answered depending on the previous filter question. The questionnaire addressed episodic memory and was not investigating potential knowledge growths. It was thus possible to record whether object memory or spatial memory was activated.

To conduct this study, in accordance with the exploratory, qualitative design, a small sample with a total of 10 test subjects was drawn within a cut-off method. A common

5 For more complete results the same procedures would have to be performed in a directional seated and tilted dome theater as well.

6 This was not actively used within the test setup. If one adjusts individual software components of SteamVR, the use of a tracker with the base station is also possible without a VR headset.

7 In addition, further inaccuracies can occur due to the calibration of the tracker on the head. The author estimates these additional measurement errors in this test setup to be less than 5° in rotation and up to 3 cm in position due to the manual calibration of the tracker.

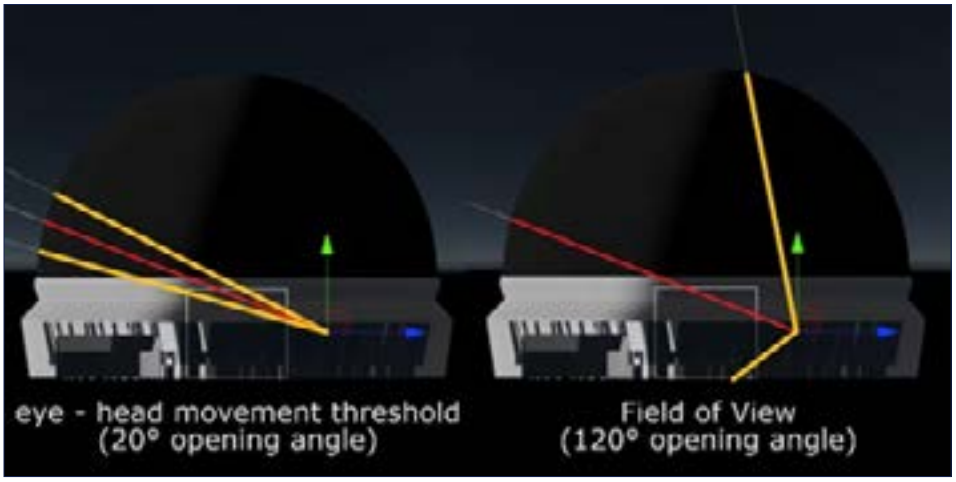


Figure 4: A screenshot from the Unity scene showing the virtual theater, the virtual tracker and the two different opening angles of both light cones. The left one illustrates the threshold, on which head movements usually support eye movements; the right image shows a simplified human field of view. (Own illustration)

Figure 5: Division of a domemaster into 5 sectors of equal height as an evaluation unit for the measured head movements. (Own illustration)

characteristic was that the subjects have never been in a planetarium before or not for at least for 5 years. This ruled out the possibility that the observed behavior was biased by previous experience with the medium.

In order to observe mainly stimulus-driven bottom-up perceptions during this study and not to trigger any active top-down processing, a false pretense was presented to the test subjects upon arrival. The subjects were asked to screen a new show sequence in advance and then give short informal feedback on it. Through this free search task, a natural reception behavior was intended. Each person was observed individually without other people present in the dome. They were sitting in the front row in the middle seat (A08), which faces directly south of the dome. When entering the room, the start-frame of the fulldome sequence was already up on the dome. After an introduction, the tracker was put on the test person's head, the distance to the eyes was measured[8], entered in the Unity application and then the fulldome content was shown. The test content had a total length of 4:11 minutes. However, the first 2 minutes were not evaluated since the eyes of the test subjects were supposed to adapt to the darkness during this time. In the test sequence, the two different image composition approaches were compared. For further systematic categorization of the head movements, a dome sector grid was developed that divides the dome into five areas of equal height (see Figure 5).[9]

After a sunset (which was not evaluated), there was about 1 minute of omnidirectional image content. Here, 5 different constellations were superimposed one after the other in the 5 individual dome sectors. The constellations faded in for 2 seconds each, were visible at full brightness level for 3 seconds and then faded out over 2 seconds. There was a 5 second pause between each constellation. During this time, no other salient stimuli were visible on the dome besides the night sky. The first constellation was Vulpecula in the west, then Gemini in the east, the Big Dipper in the north, Cassiopeia in the zenith and finally Cetus in the south. At 3:04 the evaluation section for the unidirectional part began. Here, the Earth slowly rose in the south, with the camera slowly moving away from the Earth's surface.[10] To later clearly attribute the behavior to the visual content, calm background music (from sleep by Max Richter) was chosen, and a live presentation was dispensed with.

As the test subjects viewed the content, their head movements were tracked and visually displayed via the interface of the Unity application. The material was saved via a screen capture. After watching the short fulldome sequence, the test persons received the questionnaire.

The video material obtained is coded and evaluated according to the rules of a qualitative content analysis according to Mayring and Frenzl (2014). For this purpose, mainly the large head movements were evaluated; for this the raycast of the tracker must have been in another dome sector for at least 1 second. The questionnaire was evaluated according to statistical characteristics.

Results and Discussion

The following part contains the major findings of this study. The observation shows that head movement has occurred during the reception of fulldome content. When the first key stimulus appeared in the west, the participants hardly moved their heads. With the following two stimuli in the east and north, this changes and the head movement increased significantly; the subjects turned their heads to be able to see the constellations in the east and north. The level of activity decreased again as soon as the stimuli were closer to the main line of sight again. Figure 6 shows how many dome sectors a person viewed on average per assessment period. In the omnidirectional evaluation section, the test subjects looked at an average of 7.9 dome sectors, although salient stimuli were only shown in 5 sectors in succession. In the unidirectional section, the test subjects moved significantly less and looked

8 None of the subjects asked what the device on their head was for.

9 One dome sector surrounds the zenith, the other sectors are placed around the horizon according to the cardinal points.

10 The content was implemented in Digistar 6 and care was taken to ensure that the test setup can be transferred to other institutions independently of the analog or digital planetarium system. The tracking station and the Unity applications run on a separate computer and are not linked to the planetarium system.

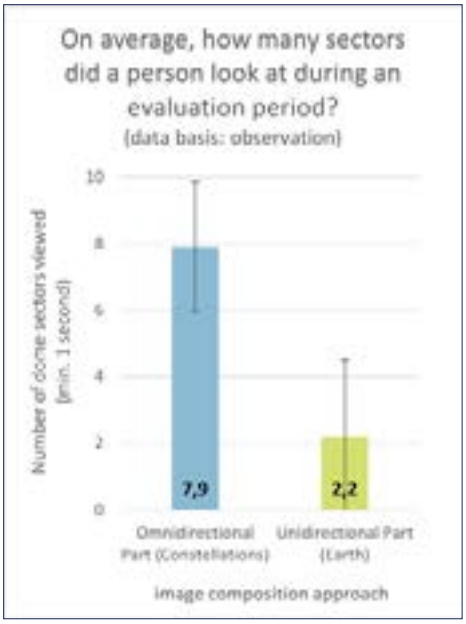


Figure 6: Evaluation of the average number of dome sectors viewed. (Own illustration)

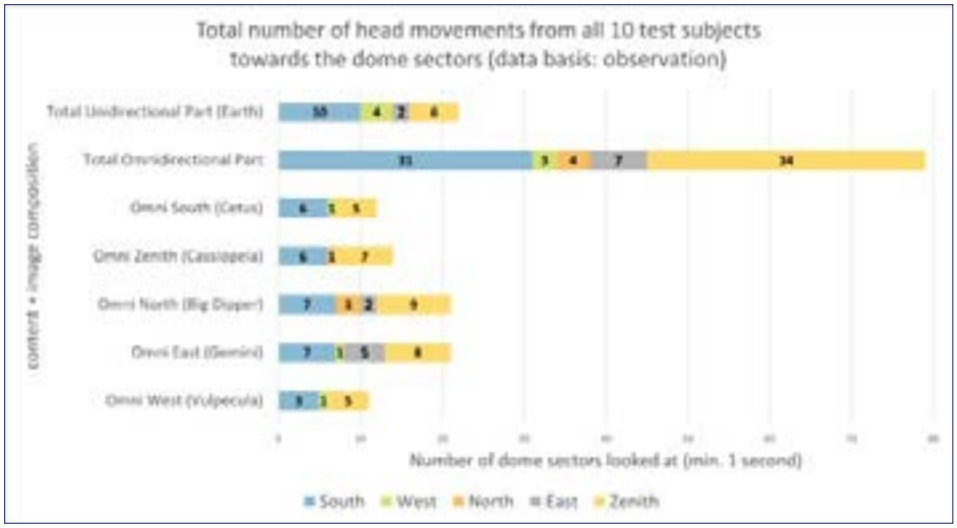


Figure 7: Evaluation of the head movement of the 10 test subjects. (Own illustration)

at only 2.2 sectors on average.

Figure 7 shows which sectors were viewed by the individual test subjects within each evaluation part and how often. The omnidirectional part is split up into the 5 key stimuli (Constellations). Here it becomes clear that in principle all dome sectors can be given visual attention. However, it is also clear that the sectors that are in the main viewing direction of the recipients (south and zenith) are viewed more frequently, regardless of the image composition approach. From the observation, it can therefore be stated that all sectors can experience visual attention.

Furthermore, the subsequent questionnaire shows that stimuli in each sector can also be remembered. As the results in Figure 8 show, the visual attention paid to the individual key stimuli is apparently so high that the stimuli can cognitively be successfully processed and also be recalled. However, these assumptions must be qualified since the quality of visual attention in relation to further processing in the cognitive apparatus decreases (1) with the angle between the main line of sight and the position of the target stimulus and (2) with the amount of head movement already made. In these cases, test subjects tended to be more insecure in both object and spatial memory and remembered these stimuli less frequently. It is also possible that these constellations were seen briefly, but the quality of visual attention was not sufficient to successfully recall this stimulus later.[11] In principle, however, all stimuli can be retrieved to a comparable extent via object and spatial memory.

For each key stimulus, the questionnaire also asked how comfortable the physical movement, turning to that stimulus, was perceived. Figure 9 shows that the physical turning to stimuli at a greater distance to the test subjects' main line of sight tended to be rated as more uncomfortable than those that lie directly in the main line of sight. In addition, this Figure also shows that the standard deviation increases after looking at the constellation placed to the north and that the main directions of gaze, zenith and south, which were then looked at, were also rated significantly more ambivalently than the attention to stimuli that tended to lie outside the main direction of gaze (east and west).

The evaluation of the questionnaire also revealed that, according to the subjective perception of the test persons, stimuli at a greater distance to the main line of sight and those for which a lot of movement had been made beforehand were also viewed for less time than those that were closer to the main line of sight.

In order to take the mixed methods approach into account, the data from the observation and the questionnaire were integrated, which means that the head movement data were compared with the answers to the questionnaire and examined for matches.[12] The results can be seen in Figure 10: Seven test subjects missed one stimulus. However, these seven people only missed one stimulus each, the one in the north or the one at the zenith. Only 3 of the 10 people saw all stimuli and also stored and recalled them via at least one type of memory (object or spatial). It can be deduced from this that the farther the target stimulus is from the main line of sight, the more likely it is not to receive visual attention.

No correlations were found between their general interest in astronomy, age or height and the results from the observation and the questionnaire.

The omnidirectional image composition was accompanied by significantly more head movements than the unidirectional image composition, but stimuli, that were further away from the main line of sight and those for which a lot of movement had previously been made were remembered more poorly. This suggests that the physical movement also influences the cognitive resources

11 In order to determine whether a stimulus was briefly seen but then not successfully remembered, eye tracking would have to be used as a method, since the methods used here can only record movement patterns of the head and the memory. Nevertheless, the option mentioned above is a possible explanation for the results.

12 For a match the test person must have looked at a dome sector and remember the corresponding stimulus in the questionnaire by at least one type of memory.

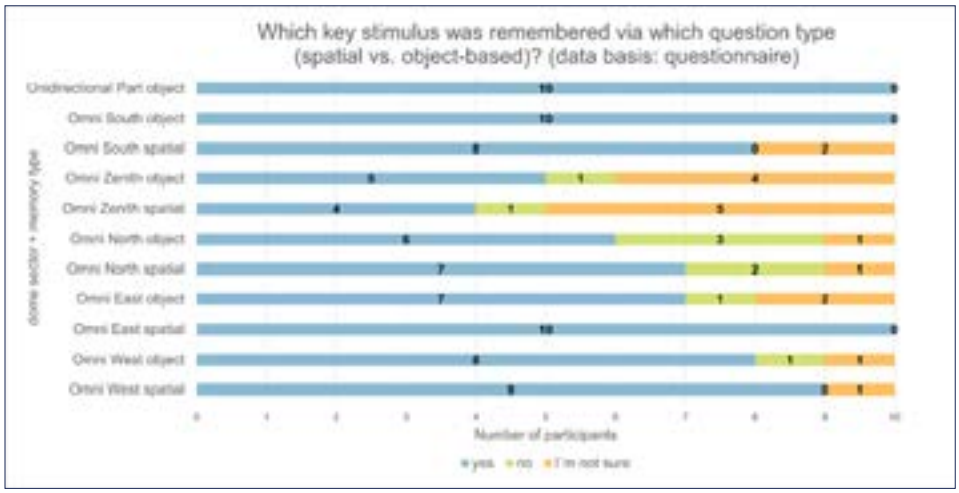


Figure 8: Evaluation of the memory capacity of the individual key stimuli via spatial and object memory. (Own illustration)

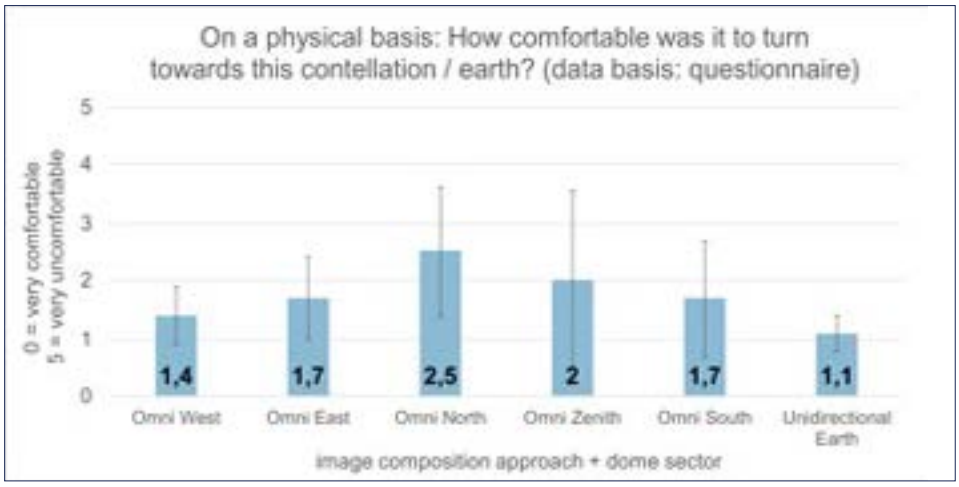


Figure 9: Evaluation of the physical movement assessment to a key stimulus. (Own illustration)

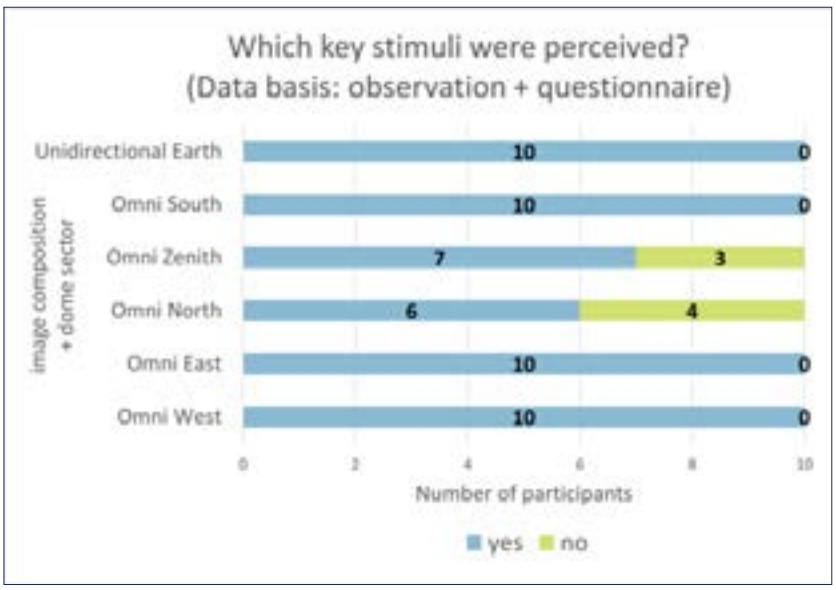


Figure 10: Integrated evaluation of the observation data and the questionnaire. (Own illustration)

or indirectly ensures that less time and resources remain to process the stimulus due to the time required for the physical movement (turning one's head towards a stimulus). Therefore, in general, the omnidirectional image composition approach seems to have more complex requirements and possibly even disadvantages compared to the unidirectional content. Further studies are needed to further qualify this relationship.

Limitations

In order to classify the results discussed here, the following limitations should be noted: The qualitative research design with its small sample size does not allow for representative statements in principle. The strength of a predominantly qualitative research design lies primarily in looking at a context in depth and uncovering many facets of a phenomenon, as they can be taken from the results section here. However, some limitations should be highlighted here:

An instrument-based observation method, like it was used in this study, is always reactive to some degree. The reactivity was tried to be kept as low as possible by various measures, e.g., by a very small and lightweight tracker model.

The analysis of the collected data has not reached the full level of detail that could have been achieved with greater effort (e.g., heatmaps & gaze plots; smaller head movements within the dome sectors have not been evaluated).

Only a short sequence of 4:11 minutes was studied (of which only 2:19 minutes were evaluated); in practice, shows tend to last 20 to 50 minutes. All effects and impacts related to the duration of reception cannot be derived from this study.

Conclusion

The results show that the image composition approach of fulldome content has an impact on the visual attention of recipients. Basically, physical movement like head movements takes place during the reception of fulldome content in the planetarium. The movement activity is closely related to the image composition approach, which determines the positioning of the stimuli in the dome. Physical movement is not only envisaged in theory for the reception of omnidirectional content, but it also actually takes place. The more omnidirectional the image composition approach

in the planetarium, the higher the level of activity in terms of head movements of a recipient; the more unidirectional the image composition approach in the planetarium, the lower the level of activity in terms of head movements of a recipient. The interpretation of the results therefore also allows the conclusion that the reception situation in the planetarium and the perception of this experience from the visitor's perspective is also dependent on the image composition: Regardless of the 360° format, in terms of physical movement the perception of unidirectional content is comparable to the passive body posture in other conventional framed mass media such as the cinema. In comparison, a planetarium with omnidirectional content differs greatly from other media, as a higher level of physical activity is required and carried out for adequate reception.

An omnidirectional image composition appears to be associated with more complex requirements in terms of directing attention through the various positions around the visitor. Visual stimuli in a 360° environment in each dome sector can not only be perceived by the recipients, but also be remembered as stimuli. They can be retrieved to a comparable extent via spatial memory as well as via object memory. Recall via spatial and object memory decreases with increasing movement of the recipient and with increasing distance of the stimulus to the main viewing direction.

In conclusion, the research question posed at the outset can be answered as follows: The image composition can direct the visual attention of a recipient in the planetarium and intend a rather passive or a rather active reception situation. The behavior of the audience and their experience is therefore not only determined by the perceptual arrangement of the architecture of a dome but can also be changed primarily by the conscious design decision in the image composition.

Disclosure statement

This paper summarizes the results of a research project (winter term 2020/21, supervised by Prof. Dr. Patrick Rupert-Kruse) and a master thesis (summer term 2021, supervised by Prof. Dr. Patrick Rupert-Kruse and Dr. Jürgen Rienow), which the author conducted at the Mediendom (Planetarium) and at the Faculty of Media at Kiel University of Applied Sciences as part of the master's degree program in Media Conception.

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THE FIRST THEORIES OF THE AURORA BOREALIS IN THE 18TH CENTURY

HALLEY'S MAGNETIC HYPOTHESIS, THE ELECTRICAL APPROACH OF CANTON AND FRANKLIN, AND THE MAIRAN-EULER DEBATE ON THE SOLAR ORIGIN

By Dr Jean-Michel Faidit, Founder, Montpellier Planetarium

The explanation of the Northern Lights stimulated scientific debate during the Age of Enlightenment. Relaunched with the great aurora of 1716, Halley's magnetic hypothesis initially became authoritative. After the aurora of 1726 and the fear caused in the Kingdom, a study by the Academy of Sciences was encouraged by the government. Mairan published his Treatise on the Aurora borealis in 1733, considering a solar origin through the contribution of matter "from the atmosphere of the Sun in contact with the terrestrial atmosphere". Following Euler's objections, he reissued it in 1754 with clarifications. At the same time, an electrical explanation enjoyed some success, with the work of Canton in 1752 and especially of Franklin in 1779. Having fallen into oblivion for more than a century, Mairan's explanation became relevant again with the work of Birkeland from 1896 and found its full confirmation through the advent of space astronomy and the demonstration of Parker's solar wind in 1962.

As with total solar eclipses, aurora borealis relationships are imbued with emotion. The grandeur of the phenomenon, its unexpected character, its colors and its impressive movements embracing the sky, trigger in the observer, astronomer or not, a questioning about these then unexplained spectacles.

Known since Antiquity, the frequency of the aurora decreased in the 17th century after the great aurora of 1621, observed by Gassendi to whom we continue to attribute the introduction of the term "aurora borealis" in 1649 in his physics work. Robert H. Eather established in 1980 that the source of this confusion dates back to Halley's 1717 memoir in the Philosophical Transactions while George L. Siscoe showed in 1978 that this expression was introduced into printed literature thirty years earlier in 1619 by Galileo and his student Guiducci in a Dissertation on comets attributing the same origin to them. Concerned with etymology in his first scholarly work consisting of identifying these phenomena in ancient sources since Aristotle and Seneca, with variable mentions depending on the era (skys in fire, torches, beams, etc.), Mairan already indicates in his Treatise that "Gassendi was not the first to impose the name Aurora Borealis on the Phenomenon", this expression dating back to Gregory of Tours (538-594), who evoked in 585 an imaginary aurora towards the north seeming to result from the increased glow of the stars : "the sky was so illuminated throughout the northern part, that if it had not been for the night, one would have thought they saw the aurora appear."

The resumption of auroral activity in the 18th century revived interest and was punctuated by three stages. Apart from a great aurora in 1686, they became more numerous in 1706. Ten years later the great aurora of March 17, 1716 occurred. It revived the interest of Halley, invited by the Royal Society of London to produce an explanation for this phenomenon. This aurora, observed in the four corners of Europe, is often dated March 6 among British authors, due to the late application of the Gregorian calendar in England. Finally, in France, the great aurora of October 19, 1726 caused fear in the kingdom and prompted a study by the Academy of Sciences.

Theories and actors involved

The auroras, located in the earth's atmosphere, relate at this time to meteorology, etymologically to the science of meteors, then classified according to different types, ranging from watery meteors (rain, snow, hail, etc.) to windy meteors (wind, storm, ...) to luminous meteors (lightning,

Fig. 1 – Les principaux acteurs du débat sur l'aurore boréale au XVIIIe siècle.

De gauche à droite : Edmund Halley, Dortous de Mairan, et Leonard Euler.

Halley, famous for identifying the comet that bears his name as periodic, encouraged Newton to publish his Principia Mathematica. An intrepid sailor, he also went to Saint Helena to produce a Catalog of the Southern Sky (Portrait by Thomas Murray in 1687).

Mairan, Permanent Secretary of the Academy of Sciences after Fontenelle, made various contributions in physics and optics. He discovered M43, neighboring the great Orion nebula (Portrait by Charles-Nicolas Cochin - Engraving by Simon Charles Miger).

As for Euler, he contributed so much to Mathematics that many high school students passing the baccalaureate are unaware of the happiness they owe to him. He introduced the notion of function and was the first to write f(x) to designate the function f applied to the argument x, in 1734. He also introduced the modern notation for trigonometric functions, the letter e for the base of the natural logarithm (also known as Euler's number) in 1727, the Greek letter Σ to denote a sum in 1755 and the letter i to represent the imaginary unit of complex numbers, in 1777 (Portrait by Johann Georg Brucker, 1756).

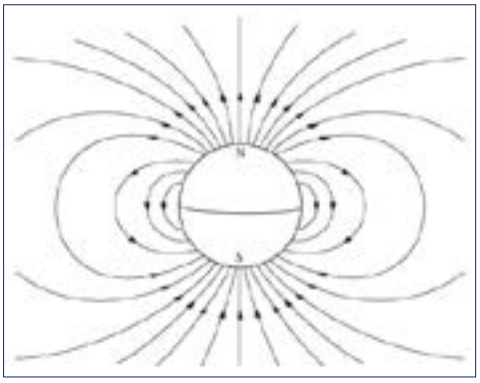

Fig. 2 - The terrestrial magnetic dipole. Channeled by magnetic field lines, auroras occur in polar regions.

rainbows and parhelia, northern lights, etc.). It is important to have this concept in mind to understand the construction of these first theories.

Halley's magnetic hypothesis

Edmund Halley (1656-1742) born in Haggerston, near London and died in Greenwich, is best known for having determined the periodicity of the comet from 1682 to approximately 76 years, named after him during the return of this comet in 1758. A long-distance sailor, in 1676 he went to the island of Sainte-Hélène to study the southern sky, publishing his Catalogus stellarum Australian in 1679.

Halley was also concerned with finding an explanation for the Northern Lights. He constructs his theoretical system in three stages. In a first memoir in 1692, he envisaged his model of the "Hollow Earth" with a "luminous" internal atmosphere, making it possible to explain the aurora borealis by water vapors expelled by an underground fire. These sulfurous vapors, by igniting in the atmosphere, were supposed to cause the appearance of boreal light. Following the consequences of Newton's theory inducing a flattening of the Earth at the poles, he modified his conception in 1705, preferring to explain the expulsions in the polar regions by this flattening.

After the great aurora of 1716 marking the end of the Maunder minimum, Halley realized that his previous conceptions were insufficient. In a memoir published in the Philosophical Transactions in 1717, he formulated his hypothesis of a magnetic core placed at the center of the Earth, and of a magnetic flux favoring exhalations through pores in the solid surface of the Earth following the lines of the magnetic field schematized by its diagram of a magnetic dipole, and foreseeing variations of the magnetic needle, confirmed in 1740 by Anders Celsius assisted by Olof Hiorter, the first to explain the auroral phenomenon by terrestrial magnetism. The aurora borealis became the polar lights with the observations of Antonio de Ulloa who in 1745 provided the first rigorous mention of an aurora australis at Cape Horn.

Celsius, author of the thermometer scale, is a Swedish physicist and astronomer, author of a work published in 1733, the same year as the Treatise of Mairan, listing 316 northern lights. Helped by his brother-in-law Olof Hiorter, in 1740 he confirmed the magnetic nature of the auroral phenomenon by observing the variations of the magnetic needle.

Franklin and Canton's electric approach

Benjamin Franklin (1706-1790), born in Boston and died in Philadelphia, is one of the greatest American physicists. Inventor of the lightning rod, he is also a recognized philosopher, politician and diplomat, co-drafter with Thomas Jefferson of the Declaration of Independence in 1776 and, as such, one of the founders of the United States.

John Canton (1718-1772), born in Stroud and died in London, was a British physicist. In 1750, he read a paper before the Royal Society in which he described a method for creating artificial magnets. In 1753, he realized that an isolated metallic object could become electrically charged without coming into contact with a charged body.

The electrical hypothesis, introduced by Benjamin Franklin and John Canton in 1752-1753, was relaunched by the first in 1779. Franklin read his dissertation on the aurora borealis at the Academy of Sciences on April 14, 1779 and developed with some success his conjecture. At the same time, Eberhart and Frisi compared its light with that of electric discharges in a vacuum. In the early 1800s, Humboldt saw aurora as the resolution of the magnetic storms that move compass needles. Morlet relaunched the question in 1819 through a synthesis of

Fig. 3 – Anders Celsius, first to verify the magnetic hypothesis. Celsius, author of the thermometer scale, is a Swedish physicist and astronomer, author of a work published in 1733, the same year as the Treatise of Mairan, listing 316 northern lights. Helped by his brother-in-law Olof Hiorter, in 1740 he confirmed the magnetic nature of the auroral phenomenon by observing the variations of the magnetic needle.

electrical and magnetic approaches, an explanation in vogue throughout the 19th century.

Dortous de Mairan, the Treatise on the Aurora borealis and its explanation of a solar origin

Man of letters and sciences like the philosophers of the Enlightenment, more physicist than mathematician, abhorring abstraction but at ease in the use of geometry and infinitesimal calculation as support for a fashionable mechanistic science, astronomer and meteorologist combining observation and design of systems for their interpretation, Jean-Jacques Dortous de Mairan (1678-1771) was Permanent Secretary of the Academy of Sciences from 1740 to 1743. His elegant style opened the Court to him: he became Secretary to the Regent and benefited from a suite at the Louvre in 1728. A brilliant mind, he was entrusted with the writing of the Journal des Sçavans in 1752. He quickly achieved European notoriety, after the publication of his Physical and Historical Treatise on the Aurora borealis, published in 1733 (with the Memoirs of the Academy for the year 1731) and republished with clarifications in 1754. A Mairan crater on the Moon, and a nebula (M 43 in Messier's catalog) which he discovered in 1731 at side of the Orion Nebula perpetuate its name.

Mairan sees in this phenomenon an interaction between the solar atmosphere and the upper atmosphere of the Earth. To support his hypothesis of a supply of solar matter igniting when penetrating our atmosphere, either spontaneously or "by collision with the particles of the air", he undertook an unprecedented compilation of historical observations, which he combined with an analysis of the various explanations put forward and his own ideas on the matter. This achievement gives him European recognition against Halley.

The Physical and Historical Treatise on the Aurora borealis was published in 1733. A Dutch edition came out shortly after in 1735. It was republished in 1754 with additions. What makes Mairan's work unique is its statistical approach. It is full of counts and tables, part of a resolutely modern methodology. In this way, he attempts to highlight cycles concerning the "recurrences of the XVIIe " and to establish correlations with the recurrences of zodiacal light, studied by Cassini in 1683, sunspots, and even comets. At the time, the dependence or independence of these phenomena was the subject of questions. Everything is scrutinized in his analysis: colors

Fig. 4 – Supporters of the electrical hypothesis of the aurora: Benjamin Franklin and John Canton.

Franklin, notably inventor of the lightning rod, is one of the founders of the United States (Portrait by Jean-Baptiste Greuze) ; Canton, a British physicist, confirmed Franklin's hypothesis on the electrical nature of lightning. Thanks to his experiments carried out between 1762 and 1764, he overturned the opinion of the Florentine academy, then generally accepted, on the incompressible nature of water.

of the aurora, particular shapes, durations, times of the year, etc. As for the height of the aurora, reinforced by the measurements of Henry Cavendish in 1768, his determination is based on a method that he first suggested in 1721, based on the zenith distance in the observation of the same source by several observers, taken up at the beginning of the 20th century by Fabry and Buisson for the altitude of the ozone layer, in correcting the atmospheric extinction due to the curvature of the Earth by the Bouguer line.

The first edition has 281 pages, the second 570 pages, or twice as much, linked to the additions to these clarifications. The reception given by his contemporaries was varied, as the hypothesis seemed bold. The comparison of the two editions of this Treatise is interesting because of their publications on either side of the Newtonian divide of 1738 during the expeditions to determine the shape of the Earth. We observe the resolutely Newtonian evolution of the author, who already admitted central forces from the first edition. Voltaire, a great actor in this distribution, particularly appreciated Mairan, not missing a note of humor to accompany the publication of his first edition, during an episode of great illness. In his correspondence of February 1, 1734, he wrote to Mairan : "Sir, Adelaide and I are emerging from agony. This is why I have not yet been able to thank you for the beautiful present with which you have honored me. I wanted to have read it before thanking you for it; but forgive a dying man who was nearing his last twilight for not having seen your aurora... Your books are like you, Sir, wise, instructive, pleasant."

Leonhard Euler

Leonhard Euler (1707-1783) was a Swiss mathematician and physicist, born in Basel and died in Saint Petersburg, who spent most of his life in Russia and Germany, notably a member of the Royal Prussian Academy of Sciences. in Berlin. Euler made important discoveries in fields as varied as calculus and graph theory. He also introduced

Fig. 5 – Aurora Borealis of September 26, 1731 observed by Mairan in Breuillepont (Eure)

(Physical and historical treatise on the aurora borealis, 1733, Plate VIII, 154).

much of the terminology and notation of modern mathematics, particularly for analysis, such as for the notion of a mathematical function. He is also known for his work in mechanics, fluid dynamics, optics and astronomy, in addition to his major role in the synthesis of the mathematical work of Newton and Leibniz founding differential and integral calculus.

He participates in the debate on the aurora borealis by expressing reservations about the origin of solar matter, preferring to see it as an impulse of solar rays on the particles of the atmosphere, as for his explanation for the tails of comets.

The Mairan-Euler debate on the solar origin of the phenomenon

Halley does not express criticism of his Treatise. After his withdrawal, it was only Leonhard Euler who expressed reservations at the Berlin Academy and through his study on the tails of comets in 1746. He proposed another approach, having as its sole basis the impulse of rays of the Sun on the atmospheres of the Earth and the Sun, and in particular applicable to comets. Atmospheric particles, thus expelled into space, would accumulate more at the poles, not dispersed by rotation and would form the northern lights. He accompanied his model with a warning against the explanation of Mairan, who reacted the following year in the Memoirs of the Academy of Sciences : "From the outset, he believed it was necessary to protect the Reader against what my hypothesis , which he is willing to call ingenious, could be attractive...". Marina measures, given the reputation of this scholar, the harm that could arise from his criticism if he left it unanswered. This is what decided him to produce a second edition enriched with 21 clarifications which appeared in 1754, and of which the first eight, constituting his response to Euler, were published in 1752 in the Memoirs of the Academy for the year 1747.

If Mairan and Euler agree around a solar atmosphere, identified with zodiacal light and flattened by rotation into a lenticular shape, their models present a first difference. Mairan defends the idea of a continuity of this solar atmosphere, capable of reaching the Earth, while Euler considers it discontinuous and less extensive. Under the effect of centrifugal force, it would result in a separate disk, like the ring of Saturn, a consequence of his first calculations on the rotation of the generating curve. If they also converge on the cause of the brightness of the auroras linked to modifications in the particles of the Earth's atmosphere, the second difference lies in the mechanism. He conceives the contribution of "clouds" of solar matter passing beyond the point of gravitational equilibrium with the Earth, entering into contact with the upper atmosphere while for Euler, it is the impulse of the solar rays, which expels particles in the earth's atmosphere. A third difference is the distance of the auroras, determined by Mairan's observations and calculations between 100 and 200 leagues altitude in the Earth's upper atmosphere. It pushes back the extent then accepted, while the particles expelled from Euler would lead to clusters further away in space.

Euler raises several objections, one of which concerns comet tails. At the time, the idea was attractive to link auroras and comet tails, developing luminous phenomena, and Euler placed them at the heart of the debate. Mairan rejects them by the fact that comets developing tails outside the solar atmosphere do not interfere in the question of the aurora on which he gives nothing. Overturning Euler's cometary objections, he made them a corollary in the debate on the aurora and, like a good polemicist, preferred to prioritize his clarifications in the reverse order: first the solar atmosphere (motivating three sections of the clarifications 3 at 5: extent, continuity, mathematical analysis of its generating curve), then the aurora borealis (lightings 6 and 7), finally the tails of comets (lighting 8). A ninth clarification is devoted to light to deal with their difference on the mechanism, that on the distance resulting from its measurements, showing that Euler's expulsions would place them too far in space, evoking also the low density of these particles at such distances to become luminous.

For the point of discontinuity of the atmosphere near the Sun, Mairan first uses observer arguments to dismantle this discontinuous hypothesis. It evokes on the one hand the continuous appearances on the Zodiac of the cones of the zodiacal light, and its maximum brilliance linked to the Sun just below the horizon. On the other hand, he relies on the descriptions of the solar corona during total eclipses, having observed two, in 1706 in Béziers and in 1724 in Paris with Godin. Secondly, he develops physicist arguments. Gravity decreasing in inverse proportion to the squares of the distance could not oppose the centrifugal force, and this ring would disappear to infinity. Thirdly, he uses mathematical analysis to study Euler's generating curve with the elements of differential calculus, reinforced in conclusion by the highlighting of a final contradiction: since the aurora,

(Continued on pg. 58)

CONTINUING PROGRESS IN PLANETARIUM CAPTIONING

By Noreen Grice - President, You Can Do Astronomy LLC

With great interest, I read the research article entitled, *Towards A More Accessible Planetarium: Testing Captioning Options with Members of the Deaf and Hard of Hearing Community* by Jesica Trucks, Shannon Schmoll, and Kathleen Hinko that appeared in the December 2023 issue of *The Planetarian*. In their work, the authors describe testing three different strategies of captioning in conjunction with the *Big Astronomy* planetarium show.

Although much of my work in accessibility has focused on making astronomy and the planetarium more accessible for visitors who are blind or visually impaired, I led a project that created a modular captioning system at the Charles Hayden Planetarium in Boston. In the fall of 1993, I was working in the Charles Hayden Planetarium and was invited to attend a captioning demonstration at a local movie theater that was coordinated by the WGBH (Boston PBS) Caption Center. I joined an audience of deaf and hearing-impaired visitors to try out three different captioning devices: a pair of glasses that displayed captions in a tiny monitor over the right eye, a large rear-screen projection LED sign, and Vacuum Fluorescent Display (VFD) boxes that were duct-taped to the backs of several chairs. We all tried out the different devices and completed surveys about our experiences and preferences. I expected that the glasses would be the best fit for possible use in the planetarium but changed my mind when I (and many people) immediately felt vertigo from wearing the glasses. In the end, it was the VFD units that seemed most promising for use in a concentric theater.

It would take a grant from the Peabody Foundation and about a year of donated research and development from the engineering company, Design Continuum, to transform the primitive VFD units tested in the movie theater to a sleek modular captioning system that could be installed at a moment's notice for pre-recorded planetarium programs. The world premier of the new captioning system occurred on May 10, 1996, at the Middle Atlantic Planetarium Society (MAPS) Conference, hosted by the Charles Hayden Planetarium. No longer did deaf visitors have to plan their planetarium visit to a particular sign language interpreted show, offered every other month. Now, they could come just like any other visitor, at any time, and simply point to a sign to request captioning. And a bonus surprise was that visitors who spoke English as a second language requested captioning and told us, "It is easier to read English than hear it." Multiple audiences benefited from captioning!

One particular memory that sticks with me is the very last show I presented in the Charles Hayden Planetarium. It was Christmas Eve, 2009, and I was just about to close the doors to begin the prerecorded *Winterlight* holiday show when the front desk radioed that a family was on their way. The family arrived and handed me their tickets and I realized that some of them were hearing impaired. I said, "We have a captioning system. Would like you like to see captions for this program?" Immediately, one of the adults said, "Yes! We need captions!" I directed them to specific seats in the back row that had a special caption post and I quickly installed a modular caption unit. As the program played, I could see a faint flicker from the caption unit and I noticed that the family was alternating their gaze between the captions and dome. After the show, the family came to the console and said that they enjoyed the captions very much and would be sure to return to the planetarium! It's one of my favorite memories because my work in accessibility began in 1984 in that same planetarium when a group of blind students did not have a favorable experience. The response from this family made me feel like a circle of inclusion and accessibility had been completed and that moment still brings a smile to my face.

You can read about the modular captioning system that was used for about 20 years in the Charles Hayden Planetarium, in the December 1996 issue of The Planetarian. (*https://cdn.ymaws.com/www.ips-planetarium.org/resource/resmgr/planetarian/v25n4-Dec1996.pdf*)

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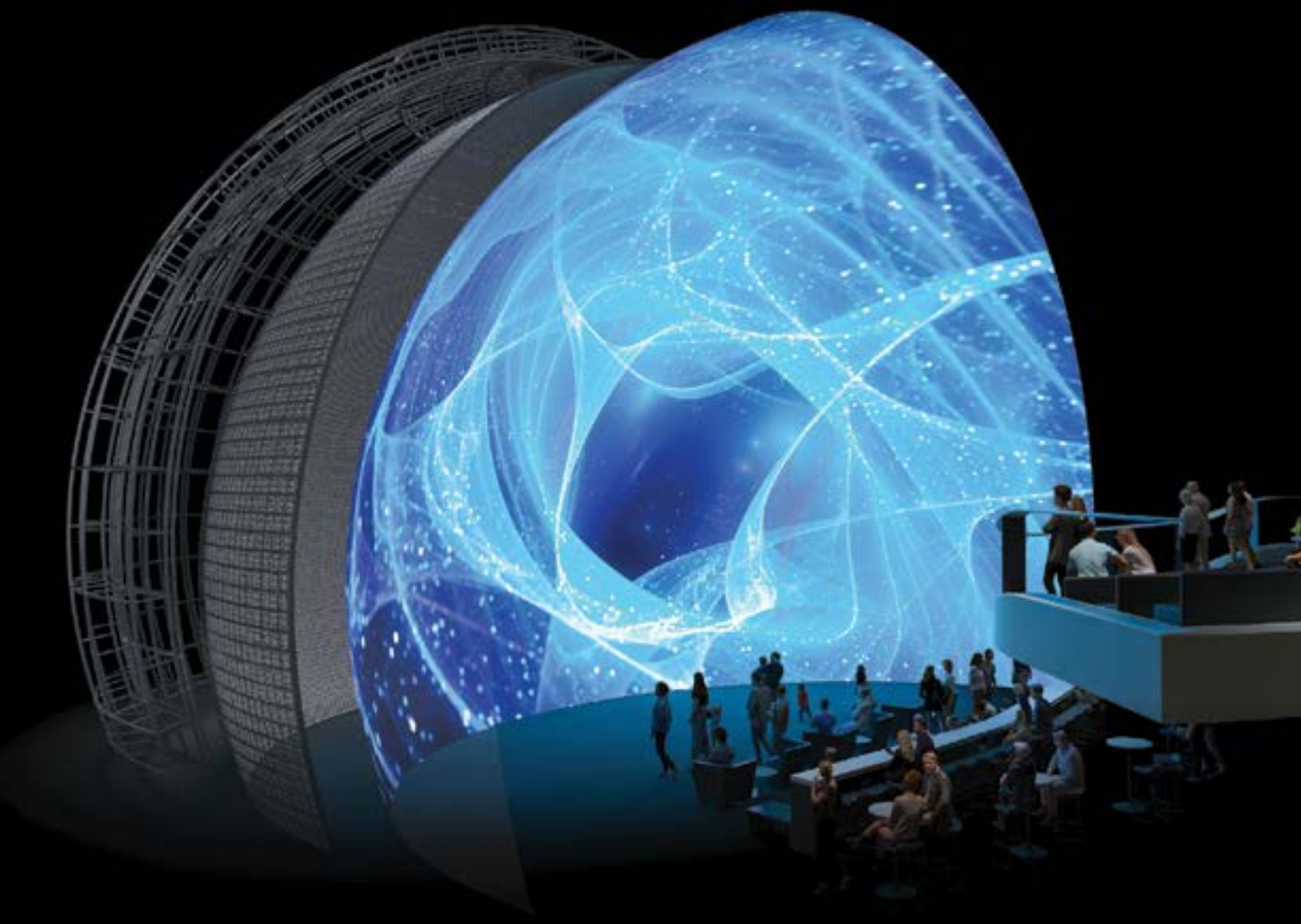

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A WEEK WITH THE GDP

By Sarah Twidal

September will always be my favorite time to travel. Of course, some of that might be due to the fact that my previous work trips had to line up with the month of September, because of the slow season at work. Now I have grown to love this month because of the weather I usually encounter where I end up traveling. Germany was no exception to this rule. Coming from a hot state, I love the cold. I tell people it must be somewhere in my DNA that I was meant for a colder climate. I honestly cannot get enough of it.

Left: Anna's Pup Laelaps. Photo courtesy of Anna Green: Photo collage courtesy of Sarah Twidal

On my travels, I met other Texans coming in for the Berlin marathon. There was also a couple from Chicago that I quickly bonded with over queue/line efficiency/inefficiency, seeing as we were stuck in the longest passport entry line. This line was so long that it had to serpentine into three areas. Newly arriving travelers were either unaware of this, or chose to ignore it, and kept making the middle of the line longer. In our conversation, we quickly discovered our mutual love for museums. One of them had worked in the art/architecture world as a consultant for many years. She had fond memories of the Adler Planetarium in Chicago, and I encouraged her and her husband to go visit it again as they hadn't been in years.

Upon arriving in Berlin at 11am I was greeted by Anna and her pup, Lälaps. I grabbed a quick coffee and croissant and we dashed to the S-Bahn. Delays in buses caused us to arrive at my hotel around 12:40pm. Thankfully, my hotel host welcomed me to check-in early and we were able to get to Berlin by 2:00pm (14:00) and lunch by 2:30pm (14:30).

While waiting between trains, I was able to buy my first German Fanta of the trip. If my mind wasn't already aware I was in a different country, then my taste buds certainly confirmed this. The reduced level of sugar of their sodas are what sodas should be! You can finally taste the flavor! Lunch at the lovely Vereinsheim Im Wiesengrund, (Clubhouse in the Wiesengrund), was exactly the meal I knew would make me feel like I had truly arrived in Germany: Wiener Schnitzel. That, plus the slower pace of the meal, ensured that both my mouth and mind had received a proper German greeting.

German cuisine is a particular favorite of mine, mostly because of my experiences of Germany early on in life. I lived in Freiburg for a year as an 8-year-old with my family and went back for three weeks when I was 17 as part of a high school student exchange program.

That evening, I had more lovely German food at the Stiftung Planetarium groups' Sommerfest. The group was very welcoming. We spoke a mix of broken English and German, talked much about bread, and had an enjoyable time looking through one of the telescopes.

After a good night's sleep, I awoke Friday to a delicious classic German breakfast of brötchen, meats, cheeses, coffee, and, of course, chocolate hazelnut spread. I visited the local Aldi for some basic supplies: mineral water, flowers, snacks, proper walking shoes, and some treats to bring back for my family.

As a mom of two kiddos, who I hope will grow to be highly independent, I more than appreciated the inclusion of kid-sized shopping carts at the Aldi. One mother and daughter in the store had only that little cart with them, and it was the 7-year-old doing all the shopping.

After my morning getting settled in, I headed into Berlin proper. I was looking forward to seeing where I would be giving my first two of three programs at the Archenhold Sternwarte (ASTW). My main work spot for the first four days of my trip was the ASTW, or Archenhold Observatory/Planetarium/exhibit hall, and Einstein lecture hall. Anna gave me a tour of the building and filled me in on many particulars of its history. The ASTW was, by and large,

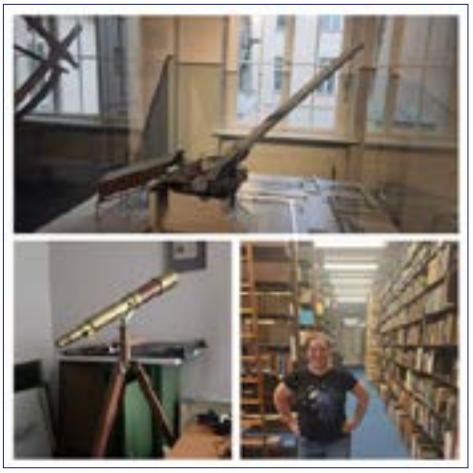

Photo collages courtesy of Sarah Twidal

protected by German law due to the historical nature of the building. It was fascinating finding out more about how the repairs, restoration, and workarounds had to happen due to these protections.

The little Planetarium was a classic gem! I more than appreciated its intimate nature and its old-school feel. Anna and I walked through my program in that dome, and all too soon it was showtime! My first audience was one of the best and kindest I have had in years. This group was so excited to finally have a program in English. They laughed at all of my jokes, interacted during the program, and asked so many wonderful questions afterward. I had honestly been very nervous up until then, and they made all of that disappear. The victory dinner afterward was another of my favorite foods available in Germany, döner kebab. By the time I got back to my hotel that night, I had walked a total of 10 miles in Germany.

Thankfully, the next day (Saturday), I found better bus routes that required less walking. After a little exploring around Berlin on my own, I ate a delicious dinner with Anna and Tilo at an Indian restaurant. Unlike most restaurants I've eaten at in the US that will rush you through your meal and hand you the bill as soon as they possibly can, this lovely place let us sit for hours. During that time, I learned about a project Anna did during her master's program. Anna created adaptations to The Little Star That Could Planetarium Show to create an accessible program for visitors who are blind or have low vision, which was implemented in the McDonnell Planetarium. She has, in the past, shared these ideas and adaptations with the Planetarium community at large, however I feel she needs to dust them off and share them in a new way beyond the conference sphere. I hope to help bring her ideas to the Planetariums in my immediate area.

Then we went to visit the Bramburg Refractor at the Wilhelm Foerster Observatory. It really is incredible to have observatories preserved and still in use in such a highly populated city center. Despite its population density, Berlin's light pollution seemed to be far less than there than what I have experienced in the Dallas-Fort Worth area of Texas. It goes to show that you can strike an odd but nice balance between nature and urban aspects even in a large city.

On Sunday I had the chance to watch one of the moderators at the ASTW give a program in German. She knew the system like it was an old friend, the history of the place like it was her own, and the stars like they were family. My German knowledge mixed with my astronomy knowledge helped me understand a solid 70% or more of what she said. Not long after her program, I gave my second show to an equally wonderful audience as the day before.

Sadly, later that night I found out what it means to be stranded in a foreign country, at least temporarily, and how odd the bus system can be on a Sunday evening in Germany. I was early for my last bus back to my hotel. However, it took an hour of waiting for me and other travelers to discover that a "replacement" bus service was running, and not in the same direction. I spent another hour finding a gas station, getting my phone charged enough to contact a taxi service, and three taxi services later, one finally came and picked me up. My dinner plans, now scrapped, turned into me picking up a pizza from the Italian restaurant across the street that was just about to close. Long story short, buses into Berlin during the day are wonderful, reliable, and more than on time. Leaving the city any time after 6pm? Just get a taxi.

On Monday I took the advice from some of my show guests from the day before and booked my security check at BER airport for Wednesday, and my taxi to the airport for 5 am. I had grown weary of relying on public transport outside of daylight hours, to say the least. I found a post office where I could mail my many postcards to family, and a place to finally get my Pfand (money back for recycling) from the many plastic mineral water bottles I had saved up in my room by this point. I felt like a little kid putting those bottles into the machine. However, it felt a little less fun to get a receipt back instead of coins. As a kid, I remember going to a recycling location in my hometown in Texas. I loved the sound of the coins clinking as they dropped out. It felt like success!

After a quick lunch at a cafe, I met up with Anna and she took me on a tour of the Zeiss Großplanetarium. We walked from the Lobby to the storage zone where all the equipment for their incredible mobile planetarium INTENSE is stored! And indeed, it was just that, intense. From the amount of stuff

Photo collages courtesy of Sarah Twidal; Photos by Sarah Twidal and Anna Green.

they have to transport to the lengthy setup process, it is all very involved and...immense.

Then into the dome we went for my show practice time for Tuesday night's program, my last one in Germany. After having been in the small dome that felt like home for my first two programs, the large dome was overwhelming. I was grateful to have had so many years of working through pre-performance nerves, otherwise I might not have eaten for the rest of the day. That would have been a massive shame, seeing as that evening I finally got back to my hotel at a reasonable time to eat dinner at their restaurant. Sadly, by this point I had eaten restaurant food a lot and my stomach was longing for simple, home food. Thankfully, their vegetarian menu had something that was just right for me.

Tuesday, it was finally time to gear up for the last hurrah! I arrived early in Berlin, mailed off my last few postcards, and bought bread and apples to ease my still queasy stomach. I had the chance to watch some of the school programs in the dome that morning. The show with the penguin and the polar bear, *Polaris and the Mystery of the Polar night,* was great fun. Getting to hear more German spoken, especially at the kid level, was a new and fun challenge for my brain. I was even answering questions from the show more automatically in German rather than English. After the canned program, the staff showed off the night sky. The capabilities of the equipment they have is truly incredible! I especially like the aurora effects. I also loved hearing the ad-lib lines that true-hearted Planetarians can come up with on the spot. As the Milky Way transitioned from dark skies to city skies, the presenter said something to the effect of "Where did the Milky Way go/all the milk go? Did you guys drink it?". The kids laughed so hard, and so did I. After the program I told the presenter that the Milky Way line was my favorite line, and I would be stealing it for my own programs in future. The presenter responded that they were happy I liked it, and that it was totally spontaneous! I loved the energy and enthusiasm I saw from many of the young people I met who were in the Freiwilliges Ökologisches Jahr (Voluntary Ecological Year – a social program for German youth) with the Planetarium group in Berlin. It inspired me to encourage more potential for the same kinds of programs here in the US, wherever they can take root.

I took the time between things that day to have a salon appointment for a blow-out service, or as it was called in Berlin, 'Damen - Waschen, Föhnen, & Styling.' Being on a bigger stage means a bigger presence, and I am not ashamed to say I wanted to look my best and the stylist ensured that was the case! A quick walk, a very light dinner, one last rehearsal, and it was finally showtime! The audience of over 200 steadily streamed into the dome, and, as I suspect happens to many of us, I suddenly forgot how to stand casually. I have found that it helps my nerves to imagine that the people walking in are all friends you just haven't seen in a terribly long time.

Besides Anna's masterful use of the equipment, the thing that really set the tone for the show was the advice I got from Derek Demeter; something along the lines of, "Be yourself, bring your own flavor to the show, lean into what they might

(Continued on pg. 62)

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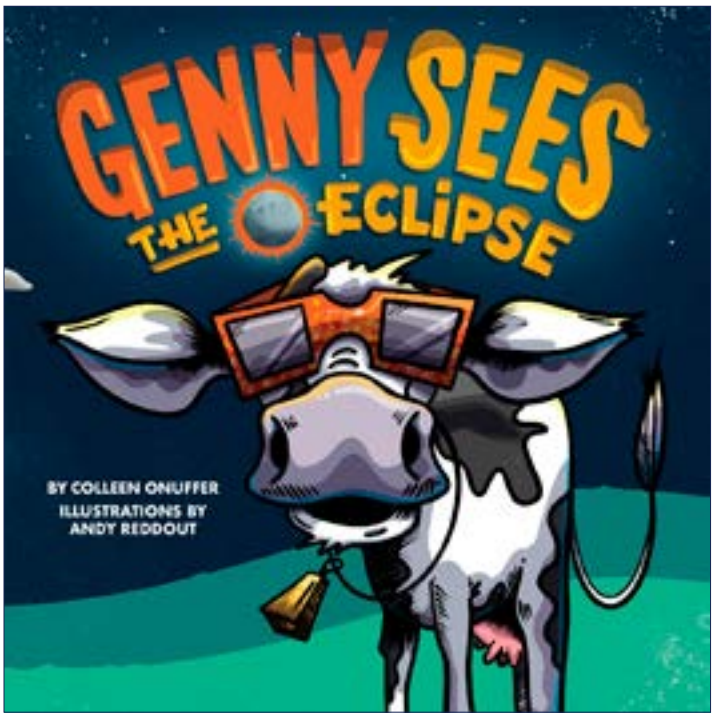
UNDER THE CLASSDOME
FINAL THOUGHTS BEFORE THE TSE

We're in the final stretch preparing for totality now. The holidays provided the last break until after the umbra sweeps over our city on April 8th. If you didn't catch it in the last issue of The Planetarian, there is a collection of resources available through the IPS website at https://www.ips-planetarium.org/general/custom.asp?page=classdomesolareclipse. A big thank you goes out to Jenny Shipway and Alan Gould for helping set that up and maintain it as more items become available.

While it will be cutting it very close for the April 2024 eclipse, here is another great resource that you could use with younger kids. A neighboring county's chamber of commerce sponsored a storybook about Genny the Cow experiencing a total eclipse. It's well done and has all the important safety information. My school district ordered copies of



Genny Sees the Eclipse.

this and a few other books for each school. https://shop.geneseetheeclipse.com/products/genny-sees-the-eclipse-original-childrens-book

My planetarium calendar is jam packed with record-setting attendance each month of this school year. In the evenings, I have been organizing our community through monthly meetings, talks to community groups and government boards, and discussions with emergency managers on how to best prepare, and attempting to get concise and correct information disseminated through the media. I've been trying to follow the advice of Ken Miller, given during his workshop at the GLPA conference in 2015. He said to make your planetarium be THE place for people to get their eclipse information. So far, so good.

A new opportunity opened up for me recently, too! There's a saying that goes "If you want something done, ask a busy person." Shawn Laatch must have been following that advice when he asked if I could be the state-level coordinator for NY with the Citizen CATE 2024 project (https://eclipse.boulder.swri.edu/citizen-cate-2024). The additional time and attention have been a challenge, but this project is really worthwhile. It's another way to make the most out of the last "Great American Eclipse" until our next one in 2045. I'm sure many of you have heard of the project, but I'd like to focus on how it provides opportunities for me as a teacher and professional. With the extra responsibility comes some great new ways to teach about science and its processes.

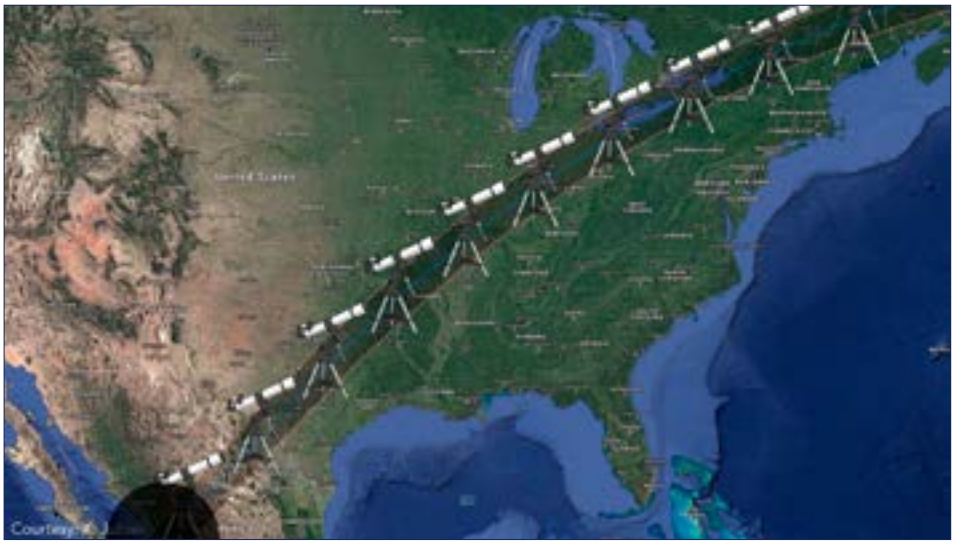
Our Next Generation Science Standards in the USA have been slightly modified here in New York State, but they are essentially the same. A new focus on the process of science is fundamental to these new standards and the Citizen CATE project is providing me with firsthand knowledge and interaction with a team of scientists testing competing models for energy flow within the solar corona. I will be able to incorporate these activities in my lessons with high school Earth Science and Astronomy students. This directly addresses these standards.

HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).

HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

The project is collecting data that will characterize the structure and flow of plasma in the inner corona. This region is very difficult to observe because it is orders of magnitude dimmer than the photosphere. Typical coronagraphs can block the photosphere's light, but they are generally a few percent to a few times larger than the photosphere's diameter. Totality is the only time that the inner corona can be studied in visible light with exceptional detail. The original Citizen CATE Experiment in 2017 successfully collected video of the inner corona from 68 observing sites along the path of totality. For the next-generation CATE experiment, the 2023 solar eclipse in Australia provided an opportunity to test a new technology. Cameras with built-in polarization



Courtesy X. Jubier/Citizen CATE 2024 team.

filters were not feasible in 2017, but they are now available at non-prohibitive costs. With 35 teams of community participants on the path from Eagle Pass, TX to Houlton, ME, Citizen CATE 2024 hopes to collect about an hour of video of totality with polarization data which will provide better characterization of the inner corona's structure and flow. This data will be made public, and others can use it to support or refute models of these important solar processes. You can learn more about the project at their website, https://eclipse.boulder.swri.edu/ (There is also another cool experiment there, flying NASA's WB-57 jets at 50,000 feet to observe the corona in infrared).

I can wrangle a Dob pretty well, but I've never gotten into astrophotography or the use of computer-controlled telescopes. The State-Level Coordinators took part in a weekend training workshop at the Southwest Research Institute in San Antonio, Texas. We learned about operating the telescope with a polarization camera and computer to collect data. We are then tasked with organizing several local teams in our state that are subdividing the data collection. We will teach the teams how to use the telescope equipment at a training workshop that the Strasenburgh Planetarium in Rochester is graciously hosting. (Thanks Jim Bader!) Teaching others is the best way for me to enhance my own understanding. These equipment operation skills can then be used in my planetarium classroom to address these standards.

HS-PS4-6. Use mathematical models to determine relationships among the size and location of images, size and location of objects, and focal lengths of lenses and mirrors.

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

The workshop also included a crash course in solar physics. The project's lead scientist, Dr. Amir Caspi, explained details about the structure and characteristics of the sun's outer zones as well as how the sun's corona affects us on Earth.

Even though I teach about these topics regularly, it was a great experience for me to learn the most up-to-date understandings and details. I understand how the plasma in the corona interacts with light much better now and this will help me be a better teacher. I will also be able to explain polarization and how the newly available polarization data will give scientists unprecedented details to work with. I'll be able to bring this into my lessons and address these standards:

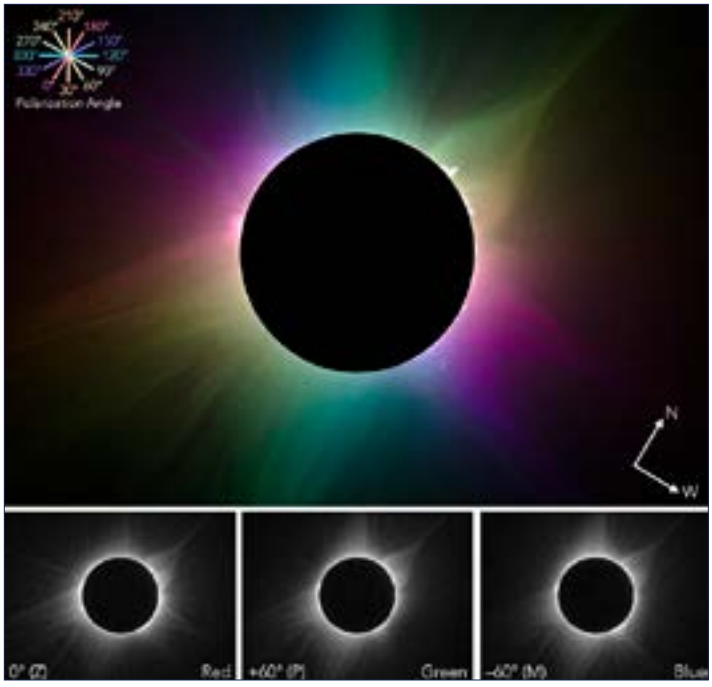
HS-PS3-4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).

HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

All Citizen CATE 2024 data becomes public domain. I also plan to use the data, images, and video to create a planetarium show. I have been incorporating science process discussions with students in the earliest grades as these

(Continued on pg. 40)



Credit: *https://iopscience.iop.org/article/10.3847/2515-5172/ad0b0d*

At the Forefront of Experience

THE WORLD'S PREMIER LED DOME SOLUTION

Prague Planetarium and Arizona Science Center's Dorance Planetarium are ushering in a new era of experiential learning, setting a new standard for engaging science and entertainment experiences through Cosm's CX System LED dome display and immersive software.

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IMMERSIVE MATTERS
SPHERE OF INFLUENCE?

Dan Neafus
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Clockwise from left: Sphere™, Las Vegas Nevada; The world's largest spherical building, the Sphere™ features a 240-foot LED dome screen; Sphere lobby inspired by the futuristic lobby of Sphere.

170,000,000 Points of Light

Almost a century ago, futurist Buckminster Fuller sketched out an early idea for an interactive informational sphere (One Town Earth sketch, 1928). By 1960 he was describing the potential benefits of a 200-foot spherical television with "10 million points on the surface of the sphere in response to signals from a computer."

He was not alone in imagining the possibilities of such a structure. Many of us in the planetarium field have discussed similar ideas for decades. I once asked Sky-Skan's Glenn Smith, "What would it take to fill all the holes in a planetarium dome with LEDs, like a giant hemispherical video screen?" He replied, "Somebody with a billion dollars could do it."

That somebody is James L. Dolan of Sphere Entertainment, who raised more than 2 billion U.S. dollars to build a 73-meter, self-illuminating dome featuring over 170 million LEDs on the interior screen.

Planetarians may be aware of similar LED technologies (COSM CX) that are being installed in the next generation of dome theaters, currently underway in LA, Prague, and Fort Worth and promising more realistic experiences than traditional projected displays.

Buckminster Fuller's dream was that his sphere would be used for greater world understanding. James Dolan's vision for Sphere is something else altogether: it is specifically designed for live performances. His concert venue opened in Las Vegas, Nevada, in September 2023 amid a flurry of excitement with astronomical ticket prices. To be clear, Sphere is a concert venue, and its vast interior accommodates exuberant, stadium-sized crowds.

The Las Vegas Sphere opening has inspired a lively dialogue on social media and in our fulldome community. This article explores some of the wide-ranging opinions shared by Sphere organization itself, by popular media, and by fulldome professionals influenced by Sphere.

"Sphere was designed to transport audiences to new places, both real and imagined." Billboard Magazine

In an article in Billboard about the product announcement, "Dolan proceeded to read an excerpt from Ray Bradbury's short story The Veldt, which describes a virtual-reality nursery with crystal walls that could reproduce any environment its users could imagine across all five senses. As he read through the excerpt, a rendering of what appeared to be a stadium-size, 360-degree, fully immersive planetarium appeared on the projector screen behind him. Suddenly, it became clear that Dolan was not simply waxing poetic about blue-sky scientific ideas: he was referencing a real, tangible project from Madison Square Garden, a portfolio of immersive, intelligent venues known as MSG Sphere."

The New York Post described the venue in glowing terms. "Sphere's stunning atrium — equipped with humanoid robots and make-your-own avatar stations, among more nods to AI and groundbreaking sound engineering, took

From top: Radio City Music Hall (left) was a prime inspiration for the Sphere (right); U2 - Image Credit Rich Fury, Sphere Entertainment.

much inspiration from his Radio City Music Hall. After all, Radio City was considered to be one of the world's most high-tech venues during its own inception nearly a century ago. Sphere's debut delivered a satisfying mix of ooh and ah moments while hearing — and experiencing — a spectacular feast for the senses."

Variety quoted James Dolan as saying,

> "No longer is the venue a place to spectate. It's a place to go and participate and will revolutionize the way artists and audiences connect via the next generation of transformative, immersive experiences."

Even the Hollywood Reporter joined the chorus of media praise for the venue. "U2 opened the Sphere concert venue; before an audience of an estimated 18,000 (including many Hollywood stars), Bono, The Edge, Adam Clayton and Bram van den Berg (sitting in for band member Larry Mullen Jr.) used these capabilities to debut their dynamic new residency, U2:UV Achtung Baby Live at Sphere, an experience that includes all of the tracks from the Irish band's 1991 album Achtung Baby, such as One and Mysterious Ways, as well as classic hits like Where the Streets Have No Name and With or Without You. U2 also used the occasion to debut its new song, Atomic City. From the opening performance of Zoo Station — during which the LED display behind the band appears as a cement wall that slowly breaks open as the show gets underway — U2 and the band's decades-long creative director Willie Williams used the orb's LED display as a canvas for a range of visual art. Sphere Entertainment Co. bet big that it can use the new venue to usher in the next generation of entertainment, and U2 gave it an exhilarating start."

The Opening Film

Perusing Sphere's own website gives interesting insight into its opening offerings. "Postcard from Earth (shown daily), a first-of-its-kind immersive film by Academy Award-nominated director Darren Aronofsky, is a portrait of our planet re-imagined as a sci-fi experience. Postcard from Earth is the first production to feature the venue's multi-sensory, 4D technologies. This includes immersive seats with an infrasound haptic system that will use deep vibrations so guests can feel the experience, such as the rumble of thunder or a soaring rocket launch. Sphere also utilizes environmental effects to rouse the senses – the feeling of a cool breeze and familiar scents – which help audiences conjure the feeling of being there."

Hollywood Reporter adds, "The U2 performances [are] averaging $1.8 million per concert and Aronofsky's Postcards From Earth [are] averaging $400,000 per showing."

When you add revenue from food, beverages, souvenirs, parking, and outdoor advertising, the Sphere is generating an impressive revenue stream for the investors.

The Technology of the Big Sky Camera

Filling the spherical screen at full resolution (16,000 x 13,500 = 216,000,000 pixels) is no small task, especially for show playback at 60 frames per second. Necessity inspired innovation, and the results are spectacular.

Deanan DaSilva, (the lead architect of Big Sky camera at Sphere Studios) described using this new technology. "Big Sky allows us to capture cinematic content at a level of detail never before possible (18,024 by 17,592 pixels)," he said, "opening up extraordinary possibilities and pushing immersive imaging technology forward in a way that will resonate throughout the entertainment industry."

The Show

Michael Daut, (IMERSA & large-format filmmaker) had the opportunity to see Postcard From Earth, in December and shares his experience:

"Much like my reaction to the groundbreaking [CX LED Dome] demo that COSM hosted for the GSCA in March of 2022, I was once again blown away by how transformational LED technology can be when applied to dome theaters," Daut said. "LED panels that cover the interior of a dome overcome nearly all the technical and physics problems that have plagued fulldome video systems since their inception. Domes that use traditional video projectors suffer from low contrast due to cross-reflection of light, relatively low brightness compared to cinema, limited projection angles to avoid shadowing, inconsistent projector alignment, etc.

With an LED dome, contrast is not a problem since the dome surface is black

View of the Sphere Experience- POSTCARD FROM EARTH, Bob Raikes, 8kassociation.com.

Big Sky Camera with 165-degree-Field-of-View, 120 FPS frame rate @ 50 Gigabytes/second, (Image 7)

and light does not bounce off of it; plus, with LED panels. Black is the 'off' mode, which makes black as black as it can be.

"Since the dome is self-illuminating, both resolution and brightness can be established by the number of pixels per panel. The maximum light level the LEDs can output is a lot. It is about 10x the brightness of digital cinema. Finally, the LEDs are fixed in place, so they remain in alignment.

In Sphere, the reported resolution is 16,000 x 13,500 (>200 MegaPixels); four times the resolution of an 8K dome display (>60 MegaPixels) and sixteen times the resolution of a 4K dome. The sheer number of pixels combined with more than 140-foot lamberts of brightness, and seemingly infinite contrast create a sublime near-real experience in the sphere. There are moments when the screen disappears and becomes a very realistic 'portal' into another place and time. LED technology in a dome, when used to its full potential, creates the closest thing I have seen to the Holodeck from Star Trek: The Next Generation.

The sound system (by Holoplot) is also quite spectacular. In a typical fulldome theater with a standard surround sound layout, the acoustics of the dome itself interact with the sound waves causing the audio to sound different in various seats in the dome. Sphere overcomes these issues by employing wavefront synthesis technology. Utilizing 168,000 loudspeakers that can direct essentially perfect surround sound to every seat in the theater. This is quite a phenomenal achievement that enhances the immersion in a never-before-possible way.

I noticed a few new challenges that this amazing technological platform creates. Most notably, because a 16K canvas can produce such an unprecedented sense of realism with its full resolution, any content presented on the screen that is less than 16K surprisingly falls short in comparison. Lower resolutions, even 8K can spoil the experience once our eyes have seen 16K in all its glory.

In Postcard From Earth, there was a wide mix of content in various resolutions with focus set between perfect and slightly soft (which also breaks the illusion of reality). I'm sure a lot of this resulted from the Sphere Studio team developing their brand new fisheye 16K camera while the film was in production. Maintaining an established look and sense of visual reality seems to be critically important and raises the stakes for producers to be able to deliver a consistent ultra-high level of visual quality never before required.

Lastly, I was surprised at the film's dark and dystopian message. I would have expected a more uplifting and inspiring show as Sphere Studio's first audience experience. I won't spoil it for you but be prepared to be the villain in the storyline of the show. All this to say that this bold experiment is an overwhelming success technologically, providing a stunning immersive audio-visual canvas that, at its best, transcends reality."

Something new?

Julieta Aguilera, IMERSA Director and long-time visualization expert, commented as well. "The Sphere venue has opened up a number of paths ahead," she pointed out. "Whereas domes are sometimes cornered into focusing primarily or even exclusively on children, especially in the United States, Sphere is a whole family or adult population experience. This has deep implications because its immersive capability is now open to the vast majority of American households, which do not have school-age kids in them.

A second path has to do with the scale of the audience: an immersive event is now available to an order of magnitude larger number of people who can experience immersion together (Sphere features 17,600 seats and standing room for 2,400 more). This is significant because this level of emotional engagement was only partially available at concerts or sport events via techniques such as choreographed projections or large screens showing the faces of performers, among others.

Furthermore, the scaling of the whole immersive environment that holds this immense, mostly adult audience has the potential of advancing both scientific and aesthetically oriented visualizations. Showcasing data and compositions in relation to human scale requires that people in the audience (hopefully beyond school age kids

Sphere's exterior display, Credit Rich Fury -Sphere Entertainment.

Sphere animation.

and their families, or science college students) understand how connections and relationships change depending on the presented scale, the dynamic navigation of scales and the visual resolution afforded throughout."

Ruth Coalson (IMERSA & independent consultant to the fulldome/immersive industry) also weighed in on the possibilities that Sphere opens up.

"I have seen a marked shift in enquiries and a rapidly building excitement since the opening of Sphere. Even though I'm based in the UK, the impact has been amazing. I have been inundated with new inquiries from many different sectors interested in this 'new' film format. I've had meetings with agents that represent well-known artists who want to perform or produce content in this space. I've also met with private entrepreneurs who want to invest in dome systems.

Sphere has made people see the beauty and the power of the immersive nature of the dome, and even more poignant is how audiences feel after they have experienced it. I'm looking forward to introducing new companies, audiences, and artists to our amazing world. Sphere has literally shined the brightest light into the industry that I love."

The Blazing Icon

Sphere's 1.2 million exterior LED fixtures outshine the surrounding gambling mecca, creating perhaps the largest advertising billboard on Earth. But this iconic and sometimes humorous animated video display is not loved by all. London's Mayor, Sadqi Khan, reacted to plans for building a similar Sphere in his metropolis.

"The significant light intrusion resulted in significant harm to the outlook of neighboring properties, detriment to human health, and significant harm to the general amenity enjoyed by residents of their own homes," he said.

Charlie Warzel (The Atlantic) had a similar reaction to Sphere: "It's the architectural embodiment of ridiculousness, a monument to spectacle and to the exceedingly human condition of erecting bewildering edifices simply because we can," he said.

Numerous planetarium consultants have expressed that well-placed and designed architecture should stand as a landmark, inviting audiences to come inside. Ideally these locations become embraced by the local community. This regional visibility and acceptance are strong influences for the long-term success of a dome theater. Certainly, Sphere is well placed, and draws attention!

Influencing our community

Of course, 360 performances in a dome are not something new. They proliferated long before any influence from Sphere. What is exciting and new is that audiences are discovering these performances in Hamburg, Brno, Denver, Jena, Boulder, Heilbron, Montréal, Melbourne, Boston, Plymouth, Cardiff, and dozens of other dome theaters around the world.

Yet, it is clear that Sphere's marketing has greatly raised awareness about fulldome experiences. It is pretty exciting to read and hear reporters using our jargon: multisensory immersive storytelling, experiential technologies, immersive cinema, and 3d-spatial audio.

Some media sources also described the experience with easy-to-understand language; "The opposite of TikTok," "demanding your full attention," "making the screen disappear," "being in the middle of the action," "the future of entertainment," and a "glorious new age of cinematography."

Animator and fulldome supporter, Ken Scott, initiated a lively conversation on IMERSA's Facebook group discussion board by declaring: "Serve your local community by providing a local Sphere alternative, with as much Sphere-like content as possible. If you have a tilted dome with stadium seating, then your facility is a 'Sphere,' not a 'Planetarium.' If you want people in your community to IMMEDIATELY understand what's possible in your facility, then rebrand using 'sphere' in your facility name."

Pat Pomerleau (NEST Immersion) replied: "In my opinion, renaming all planetariums using the word 'Sphere' is not what the public wants, they want good shows for them."

Mike Smail (Adler Planetarium): "Sphere has captivated an online audience, but not one that's necessarily representative

of humanity. For our [planetarium] field, that's celebrating 100 years of existence, trend-chasing [or] renaming themselves, especially in a fashion that would further add to confusion about their identities (flat v tilted) would do more harm than good."

Maciej Mucha (Creative Planet): "I believe every planetarium in the world is unique (which is a bad and good thing simultaneously!). Striping this uniqueness now by changing the definition and the NAME because there is a new big guy in the market? I am against it. There is no hype in Poland for your American Sphere. In my bubble, the sphere gets to me ONLY because of my industry friends. I doubt any of my non-planetarium friends heard anything about Sphere. From the Marketing Perspective—we can only win by sharing the hype—while being ourselves."

Glenn Smith (Sky-Skan): "Sphere has certainly illuminated the concept of the immersive experience and I think that any human being capable of reasonable thought, and conclusion, will make the logical association with some of today's planetariums that offer wide-spectrum programming. In my humble opinion there can only be a benefit to our industry."

Reflections on Sphere

In the end, regardless of the past of fulldome and spherical experiences, Sphere does mark something of a new beginning in immersive performances. It is a purpose-built concert venue in a tourist town known for extravaganza and spectacle and its excess has made a gigantic impression. Audiences are paying big money and flocking to the spherical venue to experience concerts, and a thrill-seeking 360 film, in the state-of-the-art venue.

Social media influencers have even adopted our fulldome jargon to describe the Sphere Experience. We give our audiences something just as exciting to talk about.

We must take advantage of this growing interest in dome shows. The Sphere hype has increased the public awareness of the exciting things that happen in dome theaters.

We offer something more sophisticated than Sphere (though less expansive). Our INTIMATE dome theaters enable more meaningful interactions between performers, audio-visual media, and audiences. The best of these experiences are enriching, poignant, and purposeful.

I am hopeful that the popular success of Sphere will inspire a growing creative community to produce more enthralling, transformational programming and timeless works of art, SPECIFICALLY FOR OUR dome environments.

Thanks to all of the contributors cited in this article, IPS and the IMERSA Board of Directors.

I am very much looking forward to continuing these discussions during IPS—IMERSA Day in Jena, Germany—on Saturday, July 20th, preceding the Berlin conference. Please look for details and updates on the IPS conference website and IMERSA.org.

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Under the Classdome (con't.)

new standards have been implemented. Kindergarteners learn what it means to make an observation. First graders learn about how to make a prediction and then observe the results of their prediction. As the grades progress, more of the science process is incorporated into their learning and activities. The image and video data generated by the project will allow me to create a compelling presentation about the process of science that capitalizes on the excitement about the solar eclipse.

This article wouldn't be complete without a big thank you to all of the Citizen CATE 2024 leaders and team members. Their work is not only making the project possible, but they were very deliberate about including workshops sessions about inclusion and cultural sensitivity, science communication, and working with the media. A major goal of the project is to include indigenous, underserved, and underrepresented communities. These are priorities for my school district as well, so this experience will help me be a leader in those efforts locally. I also want to thank Tim Collins for stepping in at the last minute and attending the workshop so that our New York team could receive the hands-on training that is so vital to the success of the project.


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INTERNATIONAL NEWS

Dear fellow planetarians...

In the news stories below from around the globe, you can read about interesting meetings and events, prize awards, many new planetarium shows (among these a Ukrainian production premiered in Germany), and a Foucault pendulum installation turned into a huge projection dome all while the USA is awaiting the 8 April solar eclipse.

For this section, I'm indebted to contributions from Milène Wendling, Loris Ramponi, Alexis Delivorias, Andreas Schmidt, Ignacio Castro, Andrew Kerr, and Amie Gallagher.

Let's start this tour around the World in France.

ASSOCIATION OF FRENCH-SPEAKING PLANETARIUMS

The APLF 2024 members' conference will be held in Strasbourg from 25-27 September in the new planetarium at the University of Strasbourg. At the heart of research in progress, the planetarium aims to showcase the use of research data in planetariums for different audiences.

After several years' wait, the new APLF website is now available at: www.aplf-planetariums.org/. Two years ago, the APLF launched a Planetarium Mediation Training Committee offering one or two days' of training each year to interested members.

ITALIAN ASSOCIATION OF PLANETARIA

Almost 30 years ago, the first European Meeting of Mobile Planetariums took place. It was held in 1995 in Lumezzane (Brescia) on the initiative of the International Planetarium Society – Mobile Planetarium Committee and the Serafino Zani Observatory (see photo). The annual meetings of the mobile planetariums continued for five years in various European locations: 1999 at Strasbourg Planetarium and Observatory (France), 2005 at Nantes Planetarium (France), 2007 at Comenius University of Bratislava, Hurbanovo Observatory (Slovakia), 2008 at Centro Multimeios Espinho, Navegar Foundation and the Center for Astrophyics of Porto (Portugal), 2009 at M. Copernicus Planetarium and Observatory, Chorzow (Poland), and 2010 at Ilpo Kuusela, Arto Oksanen, Kallio Planetaario (Finland).

As an alternative, the first online World Meetings of mobile planetariums promoted by the IPS Portable Planetarium Committee took place on 13 May, 16 September 2023, and 13 January 2024. During the last, among the many countries represented were planetarians from Italy, like Gianluca Di Luccio (Vicenza) that involves many speakers with different technical questions and Francesca Limiroli (Val di Fiemme). For more information: Susan Button *sbuttonq2c@gmail.com* and Marco Avalos Dittel *info@planetarioaventura.com.*

IAP: The participant to the first European Meeting of Mobile Planetariums (Lumezzane, Brescia, 1995). Courtesy of Loris Ramponi.

The StarLight, a Handy Planetarium adventure began in September 2013 - many proposals, many hypotheses, many dreams -Therefore last year we celebrated the first ten-year anniversary. The StarLight team enjoyed doing so with all those who collaborated, supported, and took part in the astronomical activities of the association based in Perugia in the center of Italy. At the 10th anniversary celebration of StarLight, a Handy Planetarium, APS opened on Saturday 16 September with a panel discussion entitled Making the incomprehensible comprehensible: The Role of Universities, Observatories, Planetariums, Amateur Astronomers Associations, and Local Government Administration. The initiative has been held with the aim of soliciting proposals to return astronomy to the center of our lives and our education through new ideas and renewed enthusiasm.

At the end of the panel discussion, a "Treasure Hunt of the Sun" took place along the street that leads to the Sciri Tower. At the top of the tower, they set up a telescope and instruments to track the solar spectrum. Unfortunately, the weather put a damper on the works with clouds and rain! (see photo). The celebrations ended with a concert entitled The Harmonies of Planets, which was the result of research into the relationship between music and science, following in the footsteps of Johannes Kepler. The pianist, Khalid Shomali, composed the music and StarLight produced the scientific background video.

In 2024, the National Light Pollution Day (which has taken place every year in October since 1993) will coincide with the M'illumino di Meno event. This is an initiative that has enjoyed great success for years. On 27 April 2022, M'illumino di Meno became part of the laws of the State. The Italian parliament has recognized 16 February as the National Day of Energy Saving and Sustainable Lifestyles in order to "promote the culture of energy saving and resource saving through the reduction of waste, the implementation of sharing actions, and the spread of sustainable lifestyles." This is why, since last year, M'illumino di Meno will always fall on 16 February.

The initiative is promoted, well in advance, by the hosts of the radio program, which airs all week from 6 pm to 8 pm on RAI's RADIO 2, the

IAP. Celebrating 10 years of StarLight activities. The weather put a spanner in the works with clouds and rain! Courtesy of Simonetta Ercoli.

national public broadcaster. During the program, astronomers and planetary scientists are interviewed. Last December, one of the first interviews featured Laura Bertollo (Observatory-Planetarium of the Don Paolo Chiavacci Centre, Crespano del Grappa), vice-president of the IAP, which promotes the National Day on Light Pollution. The interview was inspired by a NASA study, carried out with the help of satellites, according to which during last Christmas the city of Milan was one of the brightest on Earth. The curious news was remembered by the hosts of the radio program, who asked Laura Bertollo to comment on it. It was easy to connect the NASA study to light pollution and therefore to the national day of the same name. The communicator explained that from the distant past to today it is as if the world had turned upside down. Once, the brightest part of the night was the one that appeared upwards, the vault of heaven. In the dark cities of past centuries, before the arrival of public lighting, people without torches could not even distinguish their faces and the firmament shone with thousands of stars. Today however, the polluting lights pointlessly pointed upwards cancel out the spectacle of the night sky and the Milky Way. Dr. Bertollo explained the aims of the "Day" and the tools, such as the film projected in Italian planetariums, which aim to make the public aware of the consequences of light pollution and the solutions to limit it.

EUROPEAN/ MEDITERRANEAN PLANETARIUM ASSOCIATION

On 9 November 2023, the Rijeka Astronomical Centre in Croatia celebrated Carl Sagan Day with a special planetarium show on the most important discoveries of modern astronomy.

Also in November, the RAC hosted an Adriatic encounter of coastal "communities of technical culture," whose aim is to bring technical culture, especially informatics, robotics, and in the last few years STEM, closer to as many citizens as possible. In the meeting, representatives from six coastal Associations of Technical Culture participated from the cities of Pula, Zadar, Split, Mali, Lošinj, and Dubrovnik. The event was organized in collaboration with the Rijeka Community of Technical Culture on the 50th anniversary of the Rijeka Academic Astronomical Society in 2024.

On 8 December, the RAC Centre participated in the celebration of the 3rd Italian National Space Day with the inauguration of the satellite imagery exhibition, Looking Beyond. The Croatian version of this exhibition was organized by the RAC in collaboration with the consulate general of Italy in Rijeka promoted by the Farnesina (the Italian Ministry of foreign Affairs) together with the Italian Space Agency and Telespazio/e-GEOS and curated by Filippo Maggia.

The Rijeka planetarium participated last year in the Rijeka Advent (the period of 4 weeks before Christmas) with three planetarium programs: Christmas Story for preschool children, The Mystery of the Christmas Star for the general public and Being an Astronaut for tourists. Also, the RAC hosted a private kindergarten event under the dome for children 3-6 years old and their parents, where, apart from the Christmas Story show, young visitors were introduced to the beauty of the winter and the winter sky under the guidance of an astronomy populariser. They then had the chance to meet the "Kindergarten Santa." In December 2023 and January 2024, the RAC organized Winter Holidays for children at the planetarium with various planetarium shows, including a special show celebrating a highly successful first year of science operations for the James Webb space telescope.

At the time of writing, the Rijeka Astronomical Centre is working on five special programs to be held in February: Carnival in the Planetarium dedicated to inclusion, diversity, equity, and accessibility in collaboration with the local associations For the Better Life and SpiRiT, the Valentine's Day, the Winter School Holidays at RP, a special program dedicated to black holes, Galileo Day and the Supermoon Party.

EMPA. Opening of the Looking Beyond exhibition: Saša Zelenika, vice rector for Strategic Projects of Rijeka University (left), Davide Bradanini, consul general of Italy to Croatia (middle) and Andrea Cvitan, head of Rijeka Astronomy Centre. Courtesy of the Italian Consulate in Rijeka.

SOCIETY OF GERMAN SPEAKING PLANETARIA

Last autumn, memorial stones for Friedrich Simon Archenhold and his family were laid in Berlin. On 13 October 2023, the Stiftung Planetarium Berlin (Berlin Planetarium Foundation) commemorated the founder and namesake of the Archenhold Observatory, Friederich

Simon Archenhold, as well as his wife Alice Archenhold, daughter Hilde Archenhold, and sons Günther Archenhold and Horst "Fred" Archenhold. The "Stolpersteine" (stumbling stones) laying ceremony and accompanying event took place in the presence of the Archenhold family from Germany and abroad. The event was organized in cooperation with the Archenhold-Gymnasium and the Treptow League of Antifascists.

The Archenhold Observatory is Germany's oldest public observatory, and has borne the name of its founder, Friedrich Simon Archenhold, since 1946. It is thanks to him that the largest movable telescope in the world is located in Berlin, and that the observatory was able to develop into a place for knowledge to be publicly communicated and shared. Friedrich Simon Archenhold and his family were expelled from the observatory by the Nazi regime, and his wife Alice and daughter Hilde perished in the Theresienstadt concentration camp. By raising private funds, Friedrich Simon Archenhold made it possible to build the giant telescope with a focal length of 21 meters in 1896 and, as the founding director of the observatory in Treptower Park, was instrumental in popularizing the natural sciences. Archenhold was an active member of the international astronomy and astrophysics circles, and, thanks to him, the observatory established itself as a center of public education. He was able to attract important scientists to give lectures at the observatory; Albert Einstein, for example, spoke publicly for the first time about the general theory of relativity in what is now the Einstein Hall.

The Stolpersteine project commemorates all persecuted or murdered victims of national socialism and aims to reunite families in remembrance. Stolpersteine are therefore also laid for surviving family members at the last address they chose themselves before fleeing. The Cologne sculptor, Gunter Demnig, launched this project in 1992. Today, his Stolpersteine can be found all over Europe.

GDP. President of the Stiftung Planetarium Berlin, Tim Florian Horn (right), with members of Archenhold family. Five memorial stones (Stolpersteine) in front of the Archenhold Observatory. Both courtesy of Pedro Becerra.

GDP. Animation for the Centennial of the Planetarium.

GDP. Cover image of the podcast Einschlafen mit Weltall (Fall asleep with Space). Cortesy of Amadeus E. Fronk.

The Stiftung Planetarium Berlin celebrated the Centennial of the Planetarium on 21 October 2023 with free admission to the Zeiss-Großplanetarium, the most visited planetarium in the German-speaking world. The most popular astronomy and science programs were presented, and attendees also had the opportunity to experience Cosmic Jazz and Cosmic Rock from the Cosmic music series free of charge. Activities for children and a podcast lounge rounded off the program for the whole family.

A new podcast series to help you sleep has been produced. The podcast, Einschlafen mit Weltall (Fall asleep with Space) from the Stiftung Planetarium Berlin, in cooperation with Schönlein Media, provides fascinating knowledge about the Universe and helps you to relax and fall asleep. From the birth of a star to the measurement of the Milky Way, the podcast has been taking listeners on a nightly journey through space and time since 7 November 2023. With a new episode every Tuesday, the podcast covers topics such as how auroras are created, who is behind the "comet hunter," and when humanity will fly to Mars. Einschlafen mit Weltall is dedicated to these and other questions, from the beginnings of astronomy to current scientific findings. The texts are written by Dr. Felix Lühning from the education department of the Stiftung Planetarium Berlin and are read by Dr. Monika Staesche, deputy president of the Foundation.

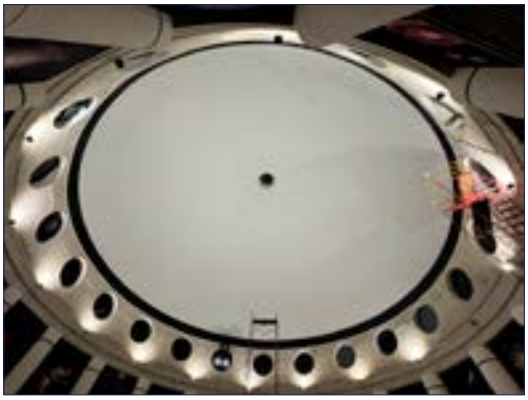
Einschlafen mit Weltall was selected by Amazon Music as one of the podcast insider tips of the year and has climbed into the top 10 of the German Apple podcast charts. With more than 25 million streams, Schönlein Media produces the most successful podcasts for falling asleep in German-speaking countries, such as Einschlafen mit Wikipedia (Fall asleep with Wikipedia), Einschlafen mit Geschichte (Fall asleep with

History), and Einschlafen mit Hogwarts (Fall asleep with Hogwarts). Schønlein Media's podcasts have won awards such as Best New Podcast 2022 from Apple Podcasts and Newcomer Podcast of the Year 2022 from Amazon Music. Einschlafen mit Weltall is available on all podcast apps and sites.

On November 23, 2023, the Ukrainian production Legends of Starry Realm premiered at the Stiftung Planetarium Berlin. Fulldome Studio DN, a production company founded at the Donetsk Planetarium in Ukraine and now based in Berlin, created the 32-minute animated film with loving illustrations and modern, 4K visualizations. The 360° fulldome production is complemented by a 25-minute live presentation from the Stiftung Planetarium Berlin. The filmmaker, Iryna Filipova, was present at the world premiere in the Zeiss-Großplanetarium. "During such a difficult time for our Ukrainian colleagues, it was a matter of course for us to organize the world premiere of Legends of the Starry Realm in the Zeiss-Großplanetarium," says Tim Florian Horn, president of the Stiftung Planetarium Berlin. Many of the constellations we know today are thousands of years old and have been passed down through Egyptian, Greek, and Roman cultures. Gods and goddesses, kings and queens, heroes, monsters, and magical objects can be found in the sky – all with their own story. Visitors can immerse themselves in the creations of a distant past under the 23-metre dome of the Zeiss-Großplanetarium with modern, fulldome image and 3D sound to learn about the myths behind the constellations of our night sky. Legends of the Starry Realm can be experienced in German and English.

ASSOCIATION OF MEXICAN PLANETARIUMS

A new planetarium, boasting a diameter of 27.40 meters, will be inaugurated in the first quarter of 2024 in Queretaro City. The Museum of Science & Technology, El Péndulo, has been transformed into a planetarium. It is among the two largest in the western hemisphere. Motivated by a vision to revitalize its space, the Museum and Science & Technology Council of Queretaro conceived the idea of projecting onto the concrete dome, centered around the iconic Foucault pendulum.



AMPAC: (From top) El Pendulo Science & Technology Museum, outside view. Negative pressure dome 27.40 m in diameter installed. Projection test during installation, December 2023. All courtesy of Planetarios Digitales.

Planetarios Digitales and an excellent team were in charge of the project and, overcoming numerous challenges as the Foucault Pendulum had to remain operating, a comprehensive solution was conceived and implemented to adapt the building without compromising its structure. The result is a unique Planetarium Theater seamlessly integrating the Foucault pendulum exhibit at its center. Completed in December 2023 and set to operate in the first quarter of 2024, the project includes a 27.40-meter-diameter negative pressure projection dome. The centerpiece is a 28-meter-high Foucault Pendulum, showcasing the Earth's rotation. Equipped with a Digistar 7 featuring 4K35 Christie RGB Laser projectors, it is equipped to comfortably accommodate 250-300 children or adults, providing ergonomic seating for an enhancing experience. The Planetarium Theater will deliver an original and very unique experience.

PACIFIC PLANETARIUM ASSOCIATION

The Lawrence Hall of Science Planetarium offers two public programs: Traditions of the Winter Sky and Mission to the Red Planet. Traditions of the Winter Sky is a newest incarnation of their classic constellations program where the audience uses star maps to find constellations. Emphasis now is on more on different cultural perspectives and traditions. In Mission to the Red Planet, in addition to learning how to locate Mars in our own night sky, the audience reviews the history of global missions to Mars – landers, flybys, orbiters, and rovers. There is also a nifty audience participation activity where a simulation of Earth and Mars orbiting the Sun is used, and the audience determines, by trial and error, the best time to launch a spacecraft from Earth to successfully arrive at Mars. There is also a new feature for drop-in visitors called "Planetarium Pilots." Between planetarium shows, drop in visitors can control the planetarium using a tablet touchscreen interface to choose which planets, moons, and more to explore.

PPA is pleased to announce their newest slate of officers. Congratulations to the new President, Jeremy Amarant.

(Continued on pg. 48)

Tom Callen
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TALES FROM DOME UNDER

"HAVE KAKSPI CAMERA, WILL TRAVEL"

Anyone who has worked on producing a planetarium show knows there are just times when you need to give yourself a little extra "push" to keep at it. Sometimes it's more than mental and needs to be physical. There are, for example, those images and clips you need to get, or have convinced yourself are worth the extra effort to get. Some could describe it as "the intrepid trek in search of one's art."

I know this quite well in one example from my time in Northern Arizona shooting all-skies with a Kakspi all-sky camera. It was part of a two-week trip in the States to attend an October 1999 Digistar Users Group meeting in Phoenix, Arizona. Starting on the East Coast, I had already shot all-skies at the Smithsonian Institution's National Air and Space Museum and the U.S. Naval Observatory, both in Washington, D.C.

Driving up from Phoenix, my base of operations was going to be Flagstaff in the northern part of "The Grand Canyon State." Having previously been there four or five times, the area was pretty familiar, which helped drawing up in advance what I needed to photograph for both the show under production as well as any extra "targets of opportunity" that presented themselves. But again, knowing the area, I already knew what those were going to be.

The all-skies to be taken during the entire two weeks—both required and extras—had been listed in order by destination and then used to figure out how many rolls of 120-type Fuji Velvia color transparency film I would need. With 10 shots per roll using the smaller, more portable model of the Kakspi camera, this came out to be 30 rolls.

Without going into details, my first two targets were Lowell Observatory (one day), and the Barringer Meteor Crater on the morning of the second day. This left covering a nearby volcanic cinder cone, with some of its surrounding lava flows, and a Native American ruin during the rest of the day.

The cinder cone, known as Sunset Crater, seems, at first, to be obviously misnamed, but it's not named for what you might think. The name refers to the very caldera, or vent, at the top of this volcanic cinder cone. Due to the geologic material it is made of, it has weathered to variations of reds, yellows, and oranges resembling those of sunset.

After taking shots of this giant cone-like tower of volcanic ash, I drove to a nearby pull off and parked. Dunes of black volcanic ash were piled everywhere in the area, and will sometimes even drift across park roads, closing them to traffic.

This stop-off was close to where you could go down an embankment and walk through an area where lava had flowed and cooled, hardening into what looked like frozen crashing waves of water. Rather than being smooth, however, it's very rough and abrasive, with sharp jagged corners and edges, so you have to be really careful. Coming into contact with any surface here is enough to convince you that you want to watch your step as you wind your way around this formation.

Setting my all-sky camera up at a low height allowed me to shoot the lava flows at an angle, which removed any unwanted background trees making the photo look too "terrestrial." This could be good material for a future show where you wanted to have an alien landscape, or even something portrayed to be part of the Moon's surface. After all, it too has volcanic lava flows, though they are from lunar volcanoes.

Climbing up out of the lava flow area, it was back in the rental car again, and off to Wukoki, one of the two major Native American ruins in the area.

The pre-Columbian Sinagua people who built it were there before the volcano erupted and created Sunset Crater. Initially having fled the area, upon returning they found out something to their benefit had happened. The soil in the area, now covered and enriched by the volcanic ash, turned out to be very good for growing crops, like corn and squash. As a direct result, they had more food, leading to an increase in their population. There was plenty to go around. They had, in essence, the volcano to thank.

Entering the Wupatki National Monument, protected by the National Park Service, I paid the entrance fee, picked up one of their NPS newspapers from a rack, and threw it over my shoulder onto the back seat when I returned to the car. There would be plenty of time to peruse this later when I got back to my hotel in Flagstaff.

By the time I drove in to the Wukoki part of the monument where there are two red sandstone pueblos (the larger Wupatki and smaller Wukoki) it was probably about a half hour before sunset. I was so intent on getting my shots with the all-sky camera I hadn't really paid attention to the fact that there were no other cars in the small parking lot. I got my camera gear and tripod out of the trunk, and I started down the simple winding path to the ruins around 100 meters away.

About halfway down this trail is when the total dead silence of the place hit me. There was no sound whatsoever except for the high-pitched chirping, snapping, and popping sounds of insects in the surrounding scrubby bush, both by the path and stretching farther away from it.

Way, way off in the distance I could see the pinpoint-sized headlights of cars and trucks as they traveled along Arizona Route 40. There were no signs of other vehicles any closer than they were. Looking in the opposite direction, it was only open landscape, rocks, and low-level vegetation to the horizon.

Forcing myself to stop walking, I did nothing for about a minute, realizing that there can't be all that many places

Kakspi all-sky image of the Wukoki pueblo. Shot on 120-format roll film, it is taken with the ProDome Oy-modified camera (the maker of this all-sky system), it's tilted 30° to match that of Cosmonova's Omnimax theater dome, so the front horizon is at the bottom. [Source: the author]

Another Kakspi all-sky image, this time taken in red rock country near Sedona, central Arizona, on the drive south to Phoenix. This is the perfect example of a "target of opportunity" photo. I particularly like this image because of the combination of the reddish-brown sandstone rocks, the green of the pine trees, and the dark blue sky. Again, the front horizon is at the bottom. [Source: the author]

where it is this quiet. I just stood there, motionless, savoring it.

My reverie over, I continued my hike into the ruins as I had to get my all-sky shots off my checklist, followed by the drive back to my hotel in Flagstaff some 45-minutes away on a two lane road. The fine-grained film I was using had a film speed of only 100 ISO, so I needed as much light as I could get.

Some shots had already been taken when I suddenly noticed that something was different. The temperature had quickly plummeted, and I got a chill as the moisture in my denim shirt began to condense. Looking up from the camera, I saw that the Sun had just now gone down below the horizon. And as soon as it did, so did the amount of ambient heat. Unfortunately, I had left my jacket back in the car; I had been in such a hurry.

With that and the falling amount of light as incentives to pick up my pace, I finished the last photos, and legged it back to the car. I couldn't resist, though, stopping one more time along the trail to have another silent minute in the middle of nowhere. It was just me and the insects, who were now becoming quieter than when I had first arrived.

The whole experience of being at the pueblo's red sandstone ruins at sunset, the stillness of the place, being in the high desert with all its sensory impressions, must have had some sort of an impact on me. And it lasted for more than a few minutes, as I soon found out.

Driving out to Route 40 to head back to Flagstaff, I wasn't really paying attention. To wit, at the intersection of the NPS road and the highway I almost pulled out in front of an 18-wheeler tractor trailer truck coming from my right. His horn-honking and flashing headlights snapped me back to my senses. Talk about a wake-up call!

It had been a long, but productive day, and I was tired, tired enough toconvince myself back at the hotel that I was just going to skip their restaurant for dinner, get room service, and take it easy the rest of the night. Tomorrow, I had to drive back down from Flagstaff and the Colorado Plateau to Phoenix for the start of the Digistar Users Group meeting. After traveling alone for over a week, it would be nice to see some old friends again, not seen since the last meeting.

While I waited for my Cobb salad, iced tea, and carrot cake to arrive at my door, I picked up the National Park Service's informative newspaper I had so casually thrown in the car's back seat hours ago at the Wupatki National Monument information center.

This is when I spotted the front-page warning article about single individuals in the area being hassled by cougars (Puma concolor, a.k.a. mountain lions) around sunset, followed by NPS's advisory not to put oneself in such a situation.

According to what I found online while writing this article, there are supposed to be something like 1,300 to 2,700 of these big cats in Arizona, and there are more in New Mexico to make a total population of 3,500 between just these two states. More can be found elsewhere. Seeing a group of humans, perhaps one of these powerful predators wouldn't be so bold, but just a person alone?

It would be no match in a "mano y gato" encounter for someone unarmed.

This nighttime view of one of these beautiful predators was taken by a camera trap in southeastern Arizona's Saguaro National Park. The largest cat species in North America, adults can be 60 to 90 cm high at their shoulders, and males can be as long as 2.4 meters from the tip of their nose to the tip of their tail. Female adults weigh between 34 – 48 kg, while males range from 53 – 72 kg. [Source: Saguaro National Park, CC BY 2.0 https://creativecommons.org/licenses/by/2.0, via Wikimedia Commons]

Sure, I had my Swiss Army "Camper" knife with me (don't leave home without it!), but I doubt a cougar would patiently wait while I got it out and opened it.

Would I have continued to try and take the all-skies at Wukoki had I known about the cougar warning? Probably, but you can bet I would have been even quicker than I was once the Sun had gone down, and the temperature in the dry Arizona air rapidly fell. I might have, however, skipped that second little moment of very quiet reverie on my way back to the parking lot.

International News (con't.)

Many thanks to Past President, Karl von Ahnen. Mary Holt continues as PPA Secretary and Alan Gould will remain PPA Treasurer for another term.

The America Astronomical Society Solar Eclipse Task Force has added a new section of resources for eclipse education and outreach: eclipse.aas.org/resources/education-outreach to the website it has put together to help everyone prepare for the 8 April 2024 solar eclipse over North America. This page links to helpful educational materials and projects at a number of organizations and could be helpful to educators at both the K-12 and college/university level.

This Date in Astronomical History offers 150+ notable events and people to celebrate. A recently compiled astronomical calendar by Andrew Fraknoi lists, month by month, 158 astronomical anniversaries and birthdays that are important for the history of our understanding of the Universe. While many such calendars exist, this one differs by focusing on real astronomical research (and not so much on anniversaries of human space flight). And it includes a more diverse group of scientists, including more women and more people of color. The calendar is available for free at: *bit.ly/astrodates* (click on the box "Full Text Available").

The Astronomical Society of the Pacific gave two awards of interest to the readers of this newsletter at its awards banquet on 11 October. The 2023 Klumpke-Roberts Award, given for a lifetime of outstanding contributions to the public understanding and appreciation of astronomy, goes to Don McCarthy, University of Arizona distinguished outreach professor and the director of the University's world-renowned astronomy camps. The 2023 Andrew Fraknoi Supporters Award, which recognizes individuals who have made significant contributions towards ASP's educational mission, goes to Edna DeVore, former director of education and public outreach, and former CEO, for the SETI Institute, and a long-time board member and officer of the ASP. For more on the Educational Awards that the ASP gives each year or every other year, see: astrosociety.org/who-we-are/awards. (In other years, the ASP gives its Brennan Award for high-school astronomy teaching and its Emmons Award for contributions to the teaching of Astro 101 at the college level).

MIDDLE ATLANTIC PLANETARIUM SOCIETY

Kevin Conod received the Distinguished Service Award from the Middle Atlantic Planetarium Society. This is the Society's highest honor and is a special recognition for outstanding, long-term service, dedication, commitment to excellence, and a passion for the planetarium community. Kevin has been involved with MAPS for more than 30 years, editing the newsletter and serving on the board. Congratulations, Kevin!

MAPS. Kevin Conod with the Distinguished Service Award. Courtesy of Amie Callagher.

Back in 2015, a small group of colleagues in the Buffalo, New York area started a conversation about planning for the April 8, 2024, total solar eclipse, which would be passing through their city. Nine years later, there are 130 local stakeholders in the Buffalo Eclipse Consortium (BEC), including science museums, art museums, state parks, the Audubon society, and tourism organizations. They are educating their community, creating branded merchandise, reaching out to underserved populations, and getting everyone excited about the eclipse. In the few months after April's eclipse, the BEC will create an Eclipse Time Capsule with solar glasses, news articles, and notes on event planning. Ideally, this will be reopened about a year before Buffalo's next total solar eclipse in 2144.


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MOBILE NEWS NETWORK
OUTREACH WITH A MOBILE DOME

Mobile Planetariums Worldwide Meeting

At our January meeting, we had 71 attendees from over 25 countries (Brazil, Canada, Columbia, Egypt, France, Germany, Greece, Honduras, Hungary, Iraq, Islamic Republic of Mauritania, Italy, Jordan, Latvia, Nepal, Nigeria, Oman, Poland, Sweden, Switzerland, Ukraine, United Kingdom, United Arab Emirates, and USA (9 States))!

Six wonderful presentations were given:

1. Dr. Omar Fikry – Egypt. "A wrong use of the inflatable dome"
2. Lionel Ruiz – France. A variety of interesting topics including free shows and software.
3. Muhammad Muslim and Sabra Mahmoud – Iraq. Two active mobile dome businesses.
4. Air El-Laithy – Egypt. A case study.
5. Alexander Block – Sweden. OpenSpace resource.
6. Maciej Mucha - Poland. The Aesthetic of Planetarium Visuals.

We also discussed plans for Centennial events, simple, hands-on materials to enhance pre and post planetarium visits, resources available on our webpage, and the date of our next get together Link to the recording on YouTube:

https://youtu.be/3psyQnqn0dc?si=T5uFF1P76G7cOHiy There, you will also find the recording of the previous meeting on September 16, 2023!

Mark your calendars; don't miss our next exciting meeting! The International Planetarium Society invites you to join us in our next Worldwide Portable Planetarium online meeting April 13, 2024 14:00 GMT. All are welcome (owners, producers, operators, manufacturers, vendors, and collaborators) to share your unique activities, ideas, techniques, and products. For any comments or additional information, or to volunteer to make a presentation, please contact: Susan Button - *sbuttonq2c@gmail.com* or Marco Ávalos - *info@planetarioaventura.com*

Mobile Domes in Iraq

Arab Planetarium Society members Muhammad Muslim (Iraq-Basrah Planetarium) and Sabra Mahmoud (Wonder Dome) are running active mobile dome businesses in Iraq. Presentations were given during the latest zoom meeting about these enterprises.

Muhammad Muslim wrote to let me know that when he started his business, in southern Iraq, there were no astronomical domes available, so he designed and made his own canvas dome and a projector with materials available on the market. The experiment succeeded and impressed everyone.

Then, later, he purchased astronomical domes from a manufacturer in China who made the domes for him according to his specifications. Now, he has 3 astronomical domes (5 m & 8 m & 10 m) available and also bought a fisheye projector (7400 Lumens).

He added an additional part to the planetarium, which is a spaceman figure, because his work is scientific and entertaining at the same time. He always wears an astronaut costume when presenting scientific presentations inside the planetarium.

He presents scientific and entertainment shows in the mobile planetarium for children ages 4 ~ 6 years and for students of primary and secondary schools and universities. He travels with the planetarium throughout Iraq, visiting scientific

Above: This is Muhammad's new astronomical dome from a manufacturer in China and his new fisheye projector. Right: Muhammad designed and manufactured a canvas dome and a projector with materials available on the market.

institutions and providing information according to age and scientific ability, and he also has participated in cultural festivals, presenting shows for families.

He explained, "The presentations include virtual sky simulations and scientific films about the universe and space technology. We provide students with basic information about astronomical events and give them some homework to do at home. We also give them access cards in the planetarium that contain some astronomical applications for them to use afterward."

"Currently, I help many people from Arab countries, and they contact me to learn how to make a planetarium, and I provide them with all the information, and I am very happy to help them." He gave a lecture at the Arabic Astronomical Domples Association on how an astronomical business is a step-by-step process. There, he offered to make himself available to give information to everyone.

He also uses his projector to present astronomical shows in fixed astronomical domes in his city due to the malfunction of the installed projectors in those domes. Contact Information: Muhammad Muslim *amer12rr34@gmail.com*

https://www.instagram.com/groubfk?igsh=MWJlY2kwY2t1NTNsMw==

Sabra Mahmoud started a business, Wonder Dome, in northern Iraq very recently, in September of 2023, and has already had 3,900 visitors for her shows which she offers in 4 languages. Most recently she took her dome to three public events: Autumn Festival 2023, International Book Fair 2023, and New Year 2024 Festival. She works with children making space art, and holds adult workshops too, using simple and effective models for activities and demonstrations. She also offers private parties for events such as birthdays and graduations.

At our previous meeting, Sabra presented a wonderful talk on 5 planetariums of the Middle East and North Africa (MENA) region. You can see her presentation on the recording of the September 16th, 2023, meeting. *https://youtu.be/3psyQnqn0dc?si=T5uFF1P76G7cOHiy*

Contact Information: Sabra Mahmoud *sabra.2015.sm@gmail.com*

Mobile Dome in Nepal

I was excited to learn of a mobile planetarium in Nepal. The website of this planetarium explains,

"We here at Kantipur Planetarium are group of enthusiastic young lads working hard to fulfill the gap between the traditional teaching methods and the modern techniques by being available to the curious learners.

Since 2015 we have been working hard to help teaching faculty tackle the obstacles of real sky observations by providing state-of-art stimulation within the dome and filling the information gap by adding the knowledge of astronomy in the education system motivating students to pursue careers in science & astronomy. As we have travelled from east to west of Nepal, we have found the senior citizens of different regions equally interested in this field from past four years."

Check out their website to see all the exciting things they are doing: *https://kantipurplanetarium.website2.me/home*

Mobile Dome in Jordan

Ayman Al-Nairat, will be presenting information about his planetarium at the next zoom meeting on April 13, 2024 14:00 GMT. He shared some preliminary information that may entice you to come to the meeting and experience the full presentation.

Ayman wrote, "We at Star of Jordan were founded in October of 2019 and have stopped due to the Corona pandemic, but we continue during the stopping period with administrative organization, marketing, and preparing publications and advertisements."

"In the beginning, we were only two people, and the number of employees was 6 people, with 6 specializations and tasks. The 360-degree film programs use a convex mirror, Stellarium, and SkyView."

"Our audience is concentrated among school students from kindergarten to university students, and we move between schools and hold a program called a day in space consisting of 6 stations, including planetarium events. We also take advantage of the occasions to hold astronomical evenings."

"More than 280 schools and 8 events were covered, and the most beautiful place we held our shows in was in the Wadi Rum desert, where most of the filming of Mars films takes place." Contact Information: Ayman Alnairat, CEO jordan star for space science; jordanssspace@gmail.com; *https://www.jordanstarspace.com/*

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LIP SERVICE
THE POSSIBILITIES ARE ENDLESS

It's official: LIPS is now a registered 501(c)3 non-profit organization with its own employer identification number and everything! LIPS is registered in Washington state, home to my company, Digitalis Education Solutions, and our formation date was December 29, 2023. Our board has already met once, and we will have met at least once more by the time this is published.

We started exploring this possibility several years ago, but there was never time to go through the steps to make it official. It's a relief to have finally done it! Thank you to everyone who helped with this process by giving feedback and/or encouragement.

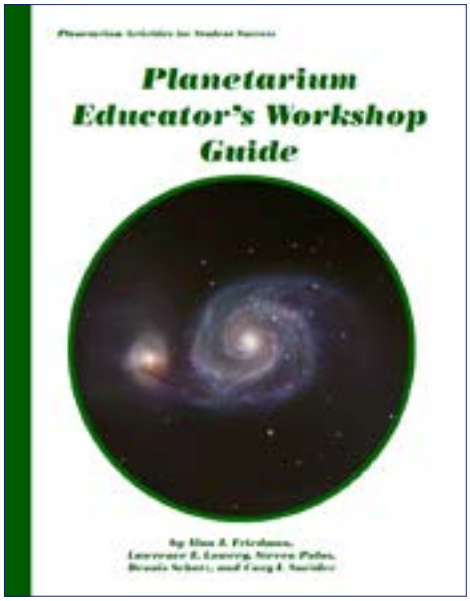
As a reminder, LIPS has a five-person board:

- Myself as President.
- Julie Tomé of the Royal Ontario Museum (Canada) as Secretary.
- Mark Webb of GOTO, Inc. as Treasurer.
- Brian Koehler of Mystic Seaport/ Treworgy Planetarium as at large member 1. Brian's primary responsibility will be conference planning, and as a previous LIPS host, he knows what to do.
- Andy Kreyche, formerly of Hartnell College, as at large member 2. Andy's primary responsibility will be leading the redevelopment of the LIPS website. If you've ever looked at the LIPS site, I'm sure you'll agree there's a lot of room for improvement!

I mentioned some of my personal big ideas for LIPS in the previous column. For this column I asked the LIPS community to weigh in with what they would like LIPS to do. Below are some of the comments I received.

Kerri Kiker, Cradle of Aviation Museum (LIPS 2019 host!):

Now that LIPS is a true organization it would be great if planetariums could request workshops or training sessions for their staff for a reasonable fee. It could be a nice way to offer staff some en masse professional development, and it would be more cost effective to bring one person to you as opposed to a lot of people somewhere else.



Planetarium Educators Workshop Guide cover, also know as IPS Special Report #10. Image from: https://www.ips-planetarium.org/resource/resmgr/education_materials/pass/v1pewg.pdf

Jeff Nee, NASA's Museum & Informal Education Alliance wrote in response to Kerri's suggestion,

I'm a big proponent of the "train the trainer" models. LIPS could have a corps of designated "master teachers" specifically trained to host mini-LIPS sessions in their regions for their local planetariums.

I'd also love to see nonprofit consulting and evaluation services to planetariums to improve existing programming and help create new programming based on evidence-based pedagogy. LIPS could even extend consulting and evaluation into non-planetarium settings, using lessons learned from the dome to bring effective, immersive learning experiences into exhibit spaces, classrooms, and libraries.

In terms of really utilizing the 501c3 status, LIPS could start applying for grants and other funding that it couldn't before, from NASA and beyond.

Fun with Kyle Doane's Insta360 camera. Image credit: Kyle Doane

https://www.nasa.gov/learning-resources/teams-engaging-affiliated-museums-and-informal-institutions/solicitations-awards/

Formalizing staff/volunteers/memberships including any payroll/dues would be nice to see as well.

A LIPS gift store and/or membership thank you gifts would be wonderful for those of us who can't attend the conference to still get some LIPS swag.

In addition, LIPS could start taking advantage of all the discounted/free goods and services that are offered to nonprofits these days for the benefit of the community.

Specifically, you already mentioned the new website. A new communications platform for the community could be great to engage those who aren't into Google Groups. Discounted printing for the aforementioned swag might help a lot to lower the barrier to support the organization.

Even just a free Google Drive for LIPS folk to freely share assets, lesson plans,

Our LIPS 2024 host Christa Speights in action in Northern Kentucky University's Haile Planetarium. Image from: https://www.facebook.com/photo/?fbid=726493566151713&set=pcb.726500376151032

Confirmation from Washington's Secretary of State that LIPS is now an officially registered entity!

planetarium code, closed captions, etc. could benefit the community a ton. I know each company has its own platforms/sites for customers to share amongst each other, but LIPS could be that cross-platform sharing space that live and interactive domes, especially analog domes, really need. After all, when I share a presenter script and an asset pack through my vendor's user group, it's not like it's useless to other systems, right?

There's a lot of food for thought here. A few quick ruminations:

- Grants and sponsorships will be critical to getting us where we want to go long term. Ideally, we would have at least one paid staff member (likely part time) who could focus all of their attention on LIPS, which would relieve some load off those of us who have fulltime jobs but still want to contribute to LIPS.
- Consulting and evaluation services are great suggestions, and I think they would complement training nicely. We've had brief discussions in the past about deciding what a "LIPS-approved" presentation looks like. This is something we should attempt to quantify, along with formulating certification for LIPS trainers.
- LIPS swag would be fun! Currently all we have available is the holographic sticker (which looks much better in real life than it does in images). I have been thinking about what we might sell to help support the operating costs. Please contact me if you have suggestions for cool LIPS merch.
- A LIPS Community site is high on my wish list. That will naturally come after the website redesign.

Alan Gould of the Lawrence Hall of Science's Holt Planetarium commented,

"A little historical note pertinent to Kerri's idea that "planetariums could request workshops or training sessions for their staff for a reasonable fee." In the 1970s, 1980s, and 1990s the Lawrence Hall of Science Holt Planetarium (UC Berkeley), under Directors Alan Friedman and then Cary Sneider, held NSF summer institutes POP (Participatory Oriented Planetariums) and POPS (Participatory Oriented Planetariums for Schools).

Among the legacy products of these endeavors was the Planetarium Educators Workshop Guide that became IPS Special Report #10 and is available through the IPS web page https://www.ips-planetarium.org/page/pass. It provides lots of great resources that can be used in planetarium professional development workshops, anywhere from a few hours to three days long. Modules include:

- *Communication*
- *A Framework for Examining Planetarium Programs*
- *Organizational Patterns*
- *How the Students See It*
- *Questioning Strategies*
- *Activities for the Planetarium*
- *Creating a Planetarium Program*
- *Teaching Across the Curriculum*
- *Devising an Action Plan*

Granted these are pretty old resources, before there were even any USA education standards of any sort. But hey, some things don't change much when it comes to human relationships and learning."

If you were at LIPS 2023, you know that we had several undergraduate students attending. In fact, about 15 percent of the LIPS 2023 audience were undergrads. I do see a real need to offer training to these brand new planetarians, specifically on successful interactive presentation, and I hope that LIPS can fill that need. Alan's comments have given me some ideas on how to frame such a training.

Thanks to everyone who weighed in!

In addition to Jeff's comment above, several people pointed out that LIPS can now pursue grants and sponsorships. Through donations we hope to offer several scholarships for LIPS 2024 that will cover registration fees and offset some travel costs. Now that we are an official 501I3, donations will be tax-deductible. Stay tuned for more on

(Continued on pg. 62)

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A DIFFERENT POINT OF VIEW

A LITTLE BIT OF EVERYTHING

They say, "Time flies when you're having fun", so I must be having fun as time is sure flying by. They also say that life is like a roll of toilet paper, "The closer you get to the end the faster it goes". Not that my end is in sight, you're stuck with me as long as your stuck with me, but I find it fascinating that all of these old cliches I laughed at when I was younger are coming home to roost.

I just realized that this June will mark the tenth anniversary of giving shows in my home planetarium. This is a place designed to keep me busy in my later years and never meant to give shows other then family and friends. I guess the old adage of,"If you build it, they will come" also holds true. Now I have never advertised my little dome and never expected to get any public visitors but through word of mouth I have hosted almost 3200 people. Now I know that sounds like a bad month for some of you but I am actually surprised that so many people would come to see one of my programs. Since this is not a business enterprise for me I only offer one show a day and usually on weekends only so in an average year I will offer fifty to seventy presentations. Often no one reserves seats so an offered program just doesn't happen. I can't imagine setting up for a show and then having no one show up (I don't have to imagine as it has happened more than once). There are plenty of things to fix around the house so sitting in the dome waiting (or hoping) for visitors is just not my style.

Perhaps my most popular program I give is the annual presentation of "The Star Of Bethlehem". This is my best indicator as to how things are going. I also offer it on most Saturdays and Sundays from just after Thanksgiving until the middle of January. For those of you that remember the old optical-mechanical projector, it takes a bit of time to go in and reset the projectors for 2K+ years ago and then reset back to the present epoch. Because of this, "The Star Of Bethlehem" is the only show I give during that time period, thus it is a fairly good indicator of the popularity of my star presentations.

Now this program takes me two hours to present. Perhaps I just like to hear myself talk but there is just so much information that I just can't get it any shorter and surprisingly no one has complained yet. They don't even complain that I have no bathroom facilities to offer (well perhaps a little) but I do tell them this before they come and point out a few fast food locations on the way in or out of town.

There has been some talk on dome-L about getting more people to come to planetarium shows and I believe I read somewhere that giving shows as short as three minutes would possibly help. I'm not at all sure if I read that right but I can't imagine that a presentation that short would go over at all. For me, that would be a trailer for a coming longer work. Now even I think that two hours is a bit much but then when I watched Oppenheimer, the three hours just flew by. Perhaps I'm a better presenter than I thought.

As I look back on my statistics I can see a continuous fall off on attendance and for various reasons certainly expected, but last year while I offered twelve shows I received no interest at all. Is the show dead or is something else happening. Perhaps it's Covid, but then the Christmas of 2001 was more in the center of that beast and eight of the fourteen offered presentations had a total of thirty seven visitors. I had been averaging around one hundred people in all of the show seasons before. Thus going down to zero requests for the 2022 season could not be blamed on Covid alone. Now this last year I offered twelve shows with requests for seats in nine of them with fifty five viewers attending.

So you may be wondering what all of this is leading up to and it is simply this. People will come back, after all, you built it and they will come, but will probably want longer programs than three minutes.

While most of you have plans for the upcoming total solar eclipse, mine are still in limbo. Strange how a motel room can rent for $150 on most days and then jump to $500 to $1000 when an eclipse darkens the sky. I know that hyper inflation is at hand but this seems a bit excessive. I guess I'll just stay in the dome and hand out the rest of the eclipse glasses I have left over from last time. I've been lucky enough to see totality twice before so the odds of another clear view are not in my favor.

Keith's Captured Quips ~ Chapter Twenty- Six

"P. S. you rock out loud."

[To Ric and Jean Edelman, who funded the original construction of the Edelman Planetarium and also provide a grant to cover school admission fees] "Thank you so much for paying for our admission for the planetarium. You guys really did a good job picking the seats, they're really comfy".

"Our solar system is crazy. If you ride inside the Milky Way will you get stuck?"

"I liked the movie, the seats, and the show."

"Thank you for the most wonderful, learnful, beautiful, and amazing show ever!!!!!!! P. S. I made up the word learnful."

10 years ago (March 2014):

As we all continue in the one hundred year celebration of the planetarium projector, you might want to review Peter Volz history of the Zeiss Company, "Tracing Paths of History: Rudolf Straubel, Walter Bauersfeld, and the Projection Planetarium". An interesting history of the forming of the Zeiss Company and the history of how the projector came about. Well worth the read. This story which started in the December 2013 issue continues. I will warn you that this section of the story is less enjoyable as Hitler enters. I still recommend it as history should never be forgotten.

25 years ago (March1999):

For the substantial number of you out there that still use an electro-optical-mechanical projector, I would suggest your reading, "Planetarium Maintenance: Protecting Your Investment" by John Hare. While many people look at a projector as an almost indestructible device, these devices are actually somewhat fragile and should be operated and treated with respect. Non-thinking individuals can cause serious harm without even realizing it. Be kind and your machine should last a lifetime.

How to get more people to come to our planetariums is a theme that continuously rears its ugly head. Steve Tidey in his "Forum" column invites planetarians to post their views as to solve this problem. Old or new ideas, they are all important to help generate a continuous flow of visitors, both old and new.

45 years ago (March 1979):

Everyone should be required to take David A. Aguilar's "Planetarium Aptitude Test" which will finally answer the questions, "Have you ever wondered if you're in the right profession? Were you really cut out to spend the rest of your life in a round room with the lights turned off?" You might find out you are better off selling used cars.

If you don't find this test to your liking or if it hits too close to home, then I might suggest George Reed's article "The History and Future of Alcohoastronomy". Yes, you read that right, the collection of beer cans and the science of astronomy come together. One of the major benefits is that to collect beer cans one should empty them first. This of course was the thinking of planetarians some forty five years ago. I have taken a much more modern approach to this problem. I import kegs of planetarium ale from California and enjoy a glass or two whenever I get the blue screen of death. What more needs to be said.

With a more stable mindset, Jeanne E. Bishop brings us back to reality with "The Educational Value Of The Planetarium". While this article is again forty five years old, it is well worth reviewing today.

So you want ideas of how to get more visitors. How about David Romanowski's "Poetry and the Planetarium: A Cultural Experiment". As Mr. Romanowski states, "Planetarium productions, while becoming more diversified and elaborate ail the time, have evolved into a sort of art form themselves. In lieu of this trend, it seems apparent that the continued interaction of the planetarium and art might prove to be valuable, since the quality of what we present to the public is just as important as how many of the public we reach."

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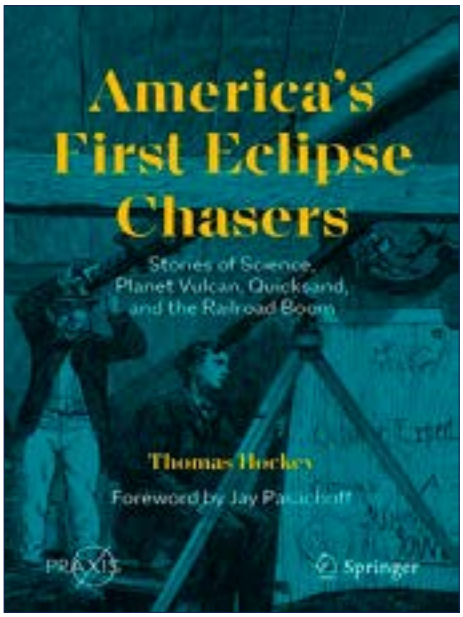
BOOK REVIEWS
NEW IN THE WORLD OF LIT



America's First Eclipse Chasers: Stories of Science, Planet Vulcan, Quicksand, and the Railroad Boom

Thomas Hockey, Chichester, UK: Springer/Praxis Publishing , 2023, ISBN 978-3-031-24123-9, US$37.99

Reviewed by Francine Jackson, Ladd Observatory, Providence, Rhode Island.

As many of us may be preparing to observe the upcoming total solar eclipse to span the United States, it might be interesting to read about the country's first major eclipse expedition: August 7th, 1869. We have to remember that at this time there were no highways – barely roads – no airplanes, and possibly the hardest to think about, no mass communication. And, yet, scientists, and nonscientists, traveled thousands of miles, many by railroad, to witness, as the author states: "There were 525,600, minutes in 1869. This is the story of three of them."

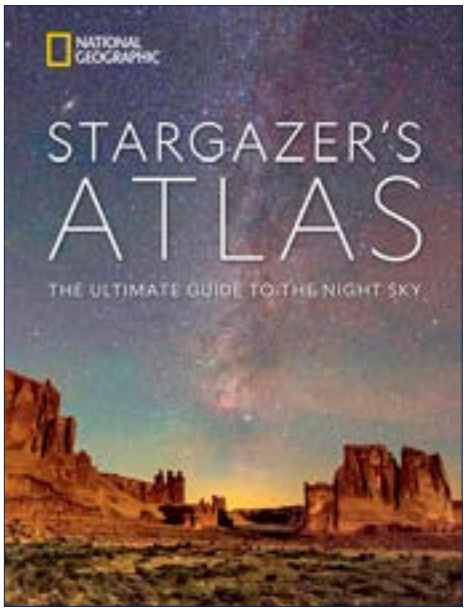
The prime observing appears to have been in Iowa, where such names as Simon Newcomb set up an observing site in Des Moines with all manner of others, college students, photographers, journalists, even a British Lord. In Burlington, Iowa, Nantucket's Maria Mitchell brought many of her Vassar college students, and her coterie was joined by teachers, surveyors, railroad employees, and an abolitionist. It is said the eclipse expanded the population of the state by over half.

In all, 82 locations were taken over by eclipse observers, and the author not only lists all the cities and towns, in Iowa and all through the path of totality, but those who traveled to watch it. Virtually all the named observers are pictured; also, to show the change in eclipse watchers, all the travelers are totally dressed – men in three-piece suits, almost all with top hats, and women with high-button shoes and hoop skirts.

Each segment of the eclipse is described in incredible detail, including the varied descriptions of the phenomenon, the travails of finding a good observing site (including one observer battling quicksand), each place's weather predictions, the "observations" of inner planet Vulcan, plus the photographs that were taken, many of which are included, along with comments made about the interpretations from each individual photographer.

A wonderful section of this book is the Foreword, by veteran eclipse observer Jay Pasachoff, who unfortunately will be missing the upcoming national eclipse. We thank him for all the great observations he made during his incredible lifetime.

America's First Eclipse Chasers is an unbelievable expedition into a journey many of us probably were unaware of, an expedition that, thankfully, today's eclipse trekkers do not have to undergo. The author takes us back in time, to relay the unbelievable efforts 19th century astronomers had to endure, just for that 3-minute time frame. My only slight comment is that it would have been nice for the author to have proofread this book just once more; however, that does not diminish the marvelous journey we readers will experience, especially those of us preparing to be modern-day eclipse chasers.



National Geographic's Stargazer's Atlas

National Geographic, 2022, ISBN 978-1426222207, US$65.00

Reviewed by John T. Meader, Northern Skies Planetarium, Fairfield, Maine, USA

I ordered a copy of National Geographic's Stargazer's Atlas when it came out in fall 2022 because one of my photographs is published within its pages (on page 340 for those who are curious). When it arrived, I was proud to play a small part in this wonderful sky atlas. This is a book that I would have loved as a kid; it would have kept me occupied for hours. Now as an adult astronomy educator, it's kept me occupied for hours, too.

My lens for evaluating such books is from the perspective of someone who teaches conceptual astronomy in a portable dome. Are concepts explored in an understandable way that don't confuse the matter? What subjects are covered? What angle is taken to keep the reader engaged and feed their curiosity? Are the illustrations helpful

to further the understanding of a concept or are they simply eye candy?

The book is divided into seven sections: stars; the sun, moon, and earth; the solar system; the constellations; deep sky wonders; how and where to explore and observe; and the future. Each chapter uses cultural and historical perspectives to explain how we know what we know, making topics accessible while allowing the reader to understand the process of discovery. This approach works with topics as diverse as spectroscopy or the formation of the solar system.

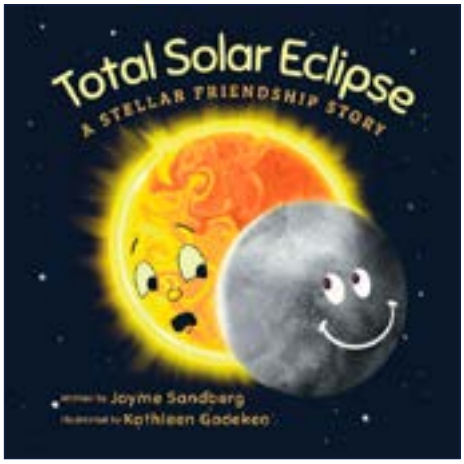
In the solar system chapter, you will find several pages devoted to each planet and the major moons, asteroids, and dwarf planets. Each is complete with descriptions, photos, and detailed maps. The only caution is to keep in mind that this book was published in 2022 and certain facts, such as the number of known moons, are soon out of date with new discoveries.

There is, in most cases, a full page devoted to each of the 88 constellations. One of the things I enjoyed are the descriptions of how constellations have been interpreted over the ages, encouraging the reader to develop their own way of picturing a constellation. Boötes, for example, can be seen as the herdsman, the bear chaser, or the ice cream cone. Included on these pages is a map of each constellation, "star stories" and "telescope targets," and a photograph of an object of interest found therein. The book also nicely cross references between deep sky objects and their associated constellations.

Seasonal star charts are provided for both northern and southern hemispheres. Each season gives a view looking north and looking south for each hemisphere, although I found it awkward to have to turn the book 180 degrees to go from southern views to northern views.

My favorite part of the book is the chapter that explores places on earth to visit such as dark sky locations, including Maine's Katahdin Woods and Waters National Monument, which I had a role in its designation as an international dark sky sanctuary, and historical sites as diverse as the Egyptian Pyramids, England's Stonehenge, Mexico's Chichén Itzá, and Turkey's Göbekli Tepe. The book also includes a terrific discussion on how to reduce light pollution, a timely topic many of us are involved in.

These are a few examples of what makes this book a welcome addition your library. It's filled with numerous fascinating tidbits and understandable explanations of the astronomy. It's not a field guide—it's too large and heavy to be taken outdoors. Instead, the book is a thorough overview of how to explore the night sky for the armchair astronomer. It might even motivate readers to get out of the chair, step into the actual night, and look up.



Total Solar Eclipse: A Stellar Friendship Story

Jayme Sandberg. Lincoln, NE: It's All Stories, LLC, 2023, ISBN 979-8-9882841-5-6, paperback, $11.99, US

Reviewed by Francine Jackson, Ladd Observatory, Providence, Rhode Island, USA.

Have you ever wondered how the Sun feels when his best friend, Moon, decides to pass right in front of him? Sun is very proud of the job he has, taking care of us Earthlings, but will they think less of him?

He also worries that suddenly Earthlings are looking directly at him; he knows that's not right, but, wait! They seem to be wearing strange glasses.

But, then, they take them off, and "love" seeing the Sun in the dark, showing his solar corona. He's so surprised, he wants to see for himself how he looks, so he tries a diamond ring! But, then, everyone's glasses come back on.

Sun is so happy how everyone liked him – plus no one was hurt – that he sends a note to Moon on how special they both are.

When it comes to introducing solar eclipses to young children, this little book is really special. A total solar eclipse, as told by the Sun, is a great way to show both how important our Sun is, and how it realizes how important it is not to observe it without special eye protection. The Sun is worried we will think less of him by being blocked by the Moon, but he learns the reverse is true, that we are grateful for him, despite leaving us for a short time.

As an introduction to the beauty of a total solar eclipse, this book will inspire children to want to see one, especially as this will be the last one in the U.S. until they reach adulthood. Families should read this as soon as possible, as our country's last total eclipse for over 20 years is fast approaching. Don't let this opportunity be lost.

The First Theories (con't.)

according to Euler, would only be produced by the impulse of the solar rays, this discontinuity of the ring would have the consequence of making it an attenuated atmosphere less conducive to this impulse.

In 1751, Euler recognized his error for the discontinuity in his correspondence with Clairaut, of which Mairan took note in his first clarification : "I was mistaken," he said, "with the candor of a true philosopher, in wanting to deduce the formation of rings of the Equation that I had found by the figure of the atmosphere of the Sun", indicating that he returns to it only for the clarity of his presentation. But as with Halley, Euler refuses to argue and the debate ends there.

While with Halley, it was two monologues, with Euler, it is a real debate, courteous, ephemeral, but intense. The Aurora Borealis, however, constituted too great a challenge for the two protagonists, confronted with a problem out of reach given the physical knowledge of the stars and the absence of mathematical tools. Faced with questions about light and matter and a lack of physical knowledge of the stars, they could only be prisoners of mechanistic models, stimulating for thought, but impossible to decide between, Euler not being able to reach the best of his theoretical power by the absence of mathematical tools.

However, there was a correct part in each model: the auroras depend on the solar wind (Mairan solar particles), they are channeled into the polar regions of the magnetosphere (Halley dipole), their light is produced by the excitation of molecules (Franklin electric discharges), following collisions caused by electrons from solar radiation (evoking the momentum of Euler rays). It is only with the advent of space astronomy and appropriate theoretical tools that we are finally beginning to be able to glimpse the true causes and mechanisms of the auroras.

The founding role of Mairan for the physics of Sun-Earth relations

Mairan's hypothesis, accepted with the edition of his Treatise, however sank into oblivion during the second half of the 18th century, discarded in favor of the electrical hypothesis introduced by Benjamin Franklin and John Canton and by the fact that the question is no longer relevant, the northern lights at low latitudes becoming less numerous from the 1780s. However, authors such as Paets van Troostwyk and Krayenhoff in 1788, still cautiously prefer Mairan's cosmic approach.

We had to wait a century for significant advances to allow this idea to rebound. In 1843 Schwabe demonstrated the one-decadal cycle for sunspots, while an identical cycle for the aurora was established by Fritz in 1862 and Loomis in 1865, who also demonstrated the simultaneous formation of the northern and southern lights.

The great aurora of February 4, 1872 revives the debate on the northern lights. Against the tide of the magnetic explanation favored by the propagations in the ether dear

Author's book on Mairan and the first theories on the Aurora boreealis. Mairan par Carmontelle et aurore en Alaska (U.S. Air Force photo by Senior Airman Joshua Strang)

to Arago or the magnetic storms of Humbolt, scientists like Auguste de la Rive or Harold Tarry lean towards a cosmic origin. The resumption of interest in the solar hypothesis of the aurora took place with Kristian Birkeland (1867-1917) through his research on their mechanism, by introducing the notion of particles trapped by the earth's magnetic field based on laboratory experiments with Carl Störmer from 1896 on the movements of electrified particles in a magnetic field. The circulation of this idea during the 19th century is linked to the transformations of this theory to adapt to the new knowledge it encounters until its integration into the Cosmic Physics of Alexandre Dauvillier, after the second international polar year (1932-1933). The ambiguity between Cartesianism and Newtonianism, by appealing to the central forces in the explanation of the phenomenon, may have favored its survival with the Cartesian revival which marked French physics at the end of the 19th century.

It was only during the second half of the twentieth century that decisive work was accomplished in its favor. In 1951, Biermann, by studying the particular orientation of comet tails, discerned the intervention of solar particle

(Continued on pg. 68)

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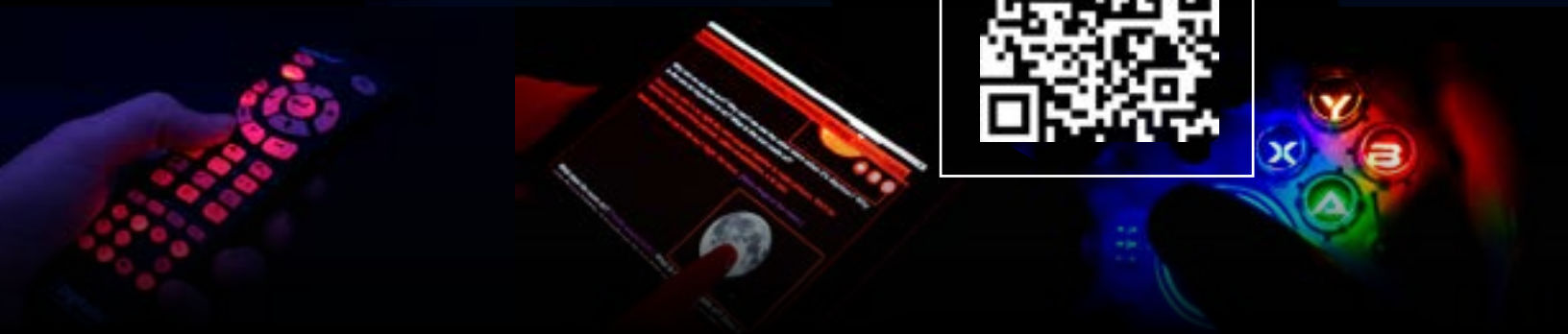

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PLANETARIUM EDUCATION

100 TIPS FOR TEACHING IN A PLANETARIUM, PT 3

Compiled, created, and edited by Ken Brandt, Co-Chair, IPS Education Committee

My colleagues and I are presenting some ideas in this series for a list of 100 of the best practices for teaching in the dome, in concert with and supporting the centennial of the planetarium. This edition features the third set of seventeen tips that concern Engagement and audience management.

How do we engage our visitors? What strategies work well for maintaining peace, while creating an environment that is open, inclusive, and meaningful?

I'll launch this set of tips with techniques from my own observations, impressions, and 30+ years of managing behavior and eliciting engagement under my dome. Here are some guidelines for setting the tone in your planetarium classroom that I have learned and used in my teaching:

1. Again, setup and first pitch set the tone for the visit. See the first article in this series. You must know what content is being utilized with this group, and the ways you'll use that as you're teaching. The room should be ready to go, with all safety protocols followed efficiently.
2. Communicate your expectations to your audiences before their visit. Keep those expectations short, positive, and comprehensive. This is your opportunity to stress details regarding cell phone use, theater decorum, and the like.
3. Have the rules posted clearly for all to see prior to entry. They should be posted wherever potential visitors will see them. Since most of my visitors are school groups, my expectations for behavior are sent out to them before they visit. This can alleviate "I didn't know" excuses, for example.
4. Emphasize the positive attributes of following the rules. For example, with cell phone use, you might actually have your audience take out their phones when the planetarium is dark, right at the beginning. You can make the point about light pollution, thus showing the audience the negative attributes of cell phone use in a dark theater without correcting negative behavior.
5. Do not make rules that you are not prepared to enforce. If you have a "no return" policy, it means nothing if there are too many exceptions to reliably enforce a rule, it needs to be abandoned.
6. If you are able to roam around the room, proximity to potential trouble is your friend. Standing near the source of a side conversation, or miscreant behaviors of a nature can be squelched just by you being in the neighborhood.
7. To promote more interaction, I ask students to write out questions about space on a 3x5 card in ink. Reading these and getting answers to these is working to increase audience interaction, as measured by the number of unique questioners responding to questions throughout the program.
8. To encourage more unique participation from some of the quieter audience members, I ask for answers only from those I haven't heard from yet. As you all know, you can have a few students "steal the interactive show" by attempting to answer all the questions. I invite those "frequent flyers" to wait until I've gotten responses from their quieter peers before calling on them again. A knowing glance, and a quick "I know that you know this one" usually get the desired response.

There are also many tips that the community has contributed to this set. Here follows some of these:

From Jenny Shipway, Education Committee Co-Chair:

1. With older students who behave a bit as though they think the event is too young for them, try using just slightly more complicated language. This has the twin effects of (i) making them concentrate more to understand, and (ii) feel like they are being treated as adults.
2. A beautifully slick presentation style is elegant, but it can be more engaging to occasionally pause mid-flow as though thinking for the right word or preparing yourself for the next bit. These pauses have been shown to increase audience attention.
3. Something magical can happen when something goes wrong with a presentation (as long as you handle it well). Audiences respond with warmth to feeling they are having a unique experience. I have known presenters who purposefully repeated glitches so they could create this feeling.
4. The way the children enter the dome will affect their subsequent behavior. Depending on the dome, audience, and presentation, you will need to appropriately balance signals that you are in charge, while also allowing them a sense of ownership of the experience. Talking to them before entry helps set the required tone.
5. For schools, it's useful to watch how the teachers manage behavior. Are they strict or relaxed? This can give clues as to what methods might work with their groups. Also, see if they have a visual signal to ask for silence.
6. If you have a large school audience who are a bit overexcited and are not quieting down when required, try to avoid repeatedly calling over them for silence (every time you fail, you will look weaker). A nice trick is to go silent and stand with one finger over your smiling lips. Some children will notice and go

IPS INTERNATIONAL PLANETARIUM SOCIETY

PLANETARIUM EDUCATION

Research Fellowship

Round 1 Proposal due:
15 March 2024

Round 2 Proposal due:
26 April 2024

USD$5000

The International Planetarium Society (IPS) is offering a USD$5000 fellowship to individuals to conduct research that helps planetarians know how best to use their spaces for educational purposes. Initial proposals will be a short overview. Some applications will then be selected to submit a full proposal.

All applicants must have an affiliation with a planetarium, an academic institution, or a planetarium professional organization.

For more information & proposal: **https://tinyurl.com/IPS-PERF**

quiet, and you can feel like you're in on a joke with them while you see how long it takes for everyone else to notice.

From Guilerme Marranghello, at the Planetário da Unipampa:

1. I introduce myself, and the two or three monitors with me, so the audience knows everybody in case they need to ask a question. As we have a small dome, we do this when they arrive.
2. I emphasize they can ask questions during the live presentations.

And finally, this piece of overarching wisdom from Ken:

1. The goal is simple: make it look like the metaphorical duck who seems calm and cool above the water, while all of the "behind the scenes" prep is quietly happening throughout, while giving the appearance of a well-oiled machine.

Engagement and a well-tempered audience can fuel increased appreciation for what you're doing at your dome, while increasing the rate of return visitation.

LIP Service (con't.)

fundraising and scholarships as our plans firm up.

Other ideas that have been floated:

- Regional LIPS gatherings, not necessarily associated with regional planetarium conferences. As Jeff pointed out, we could identify LIPS organizers across the country to assist with this.
- Creating a LIPS membership. Benefits, costs, etc. would need to be determined, along with whether there is even interest in this.
- Organizing an international LIPS. There will be a Mini LIPS before IPS 2024, but perhaps the time has come for a multi-day LIPS outside the USA?
- Do you have something on your LIPS wish list? If so, let me know!

I want to include preliminary information about LIPS 2024:

Dates: As I write this, we are conducting a survey to identify the best dates. LIPS 2024 will take place either in early August or in early September. Visit the LIPS website (LIPSymposium.org) to see which dates worked best for the most people.

Location: Northern Kentucky University's Haile Planetarium in Highland Heights, Kentucky. NKU is only about 15 miles from Cincinnati-Northern Kentucky Airport, so air travel should be quite easy.

Host: Haile Planetarium Director Christa Speights

More information will be provided as our plans firm up.

As always, I end this column with reminders about the LIPS Google Group, Live Interactive Planetarium Symposium Facebook group, and the LIPS team chat. Contact me (karrie@DigitalisEducation.com) if you need information about any of these, or if you'd like to share any ideas or feedback.

The holographic LIPS sticker is currently the only existing LIPS swag (and also hard to photograph). What would you like to see LIPS sell in an online gift shop?

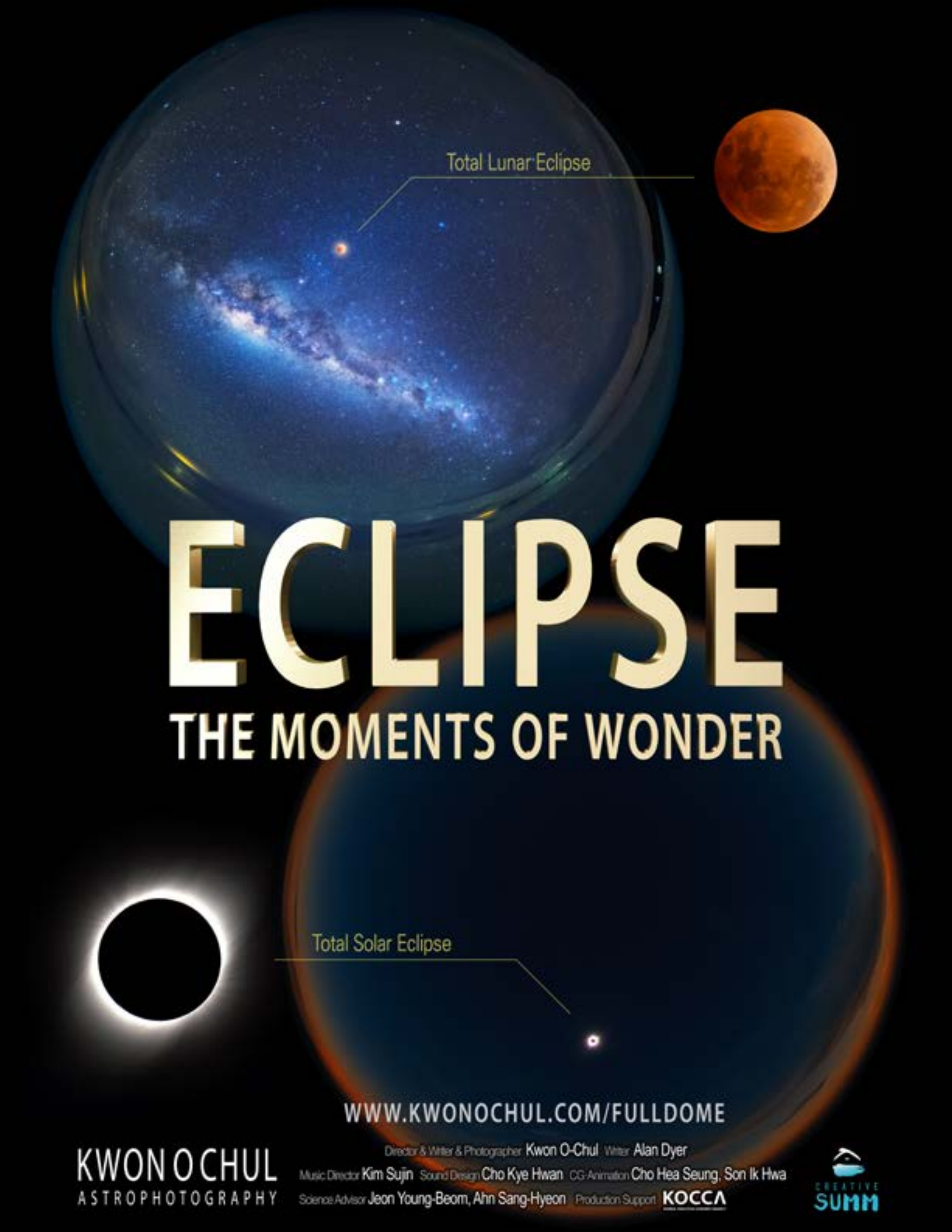
A Week with the GDP (con't.)

expect from you, and where you come from." And I did just that. I got over 200 delightful guests to sing and clap along with me to the first and most classic verses of the song "The Stars at Night." They were great fun to tell stories to, show constellations to, and even receive questions from. Folks wanted to know how I got started in astronomy, and where they could learn more. I also heard the classic kid questions of, "Do you live in space?"

The applause, the awesome goody bag the Planetarium group presented to me, and the lovely Q&A and last goodbyes, sent me off in a cloud of joy back to the hotel for one last brief sleep before the 5 alarms I'd set for between 3 and 4 am would ring.

Going to Germany was an exciting adventure and it was such a beautiful thing to come home.

Contact information: Sarah Twidal slittler61@gmail.com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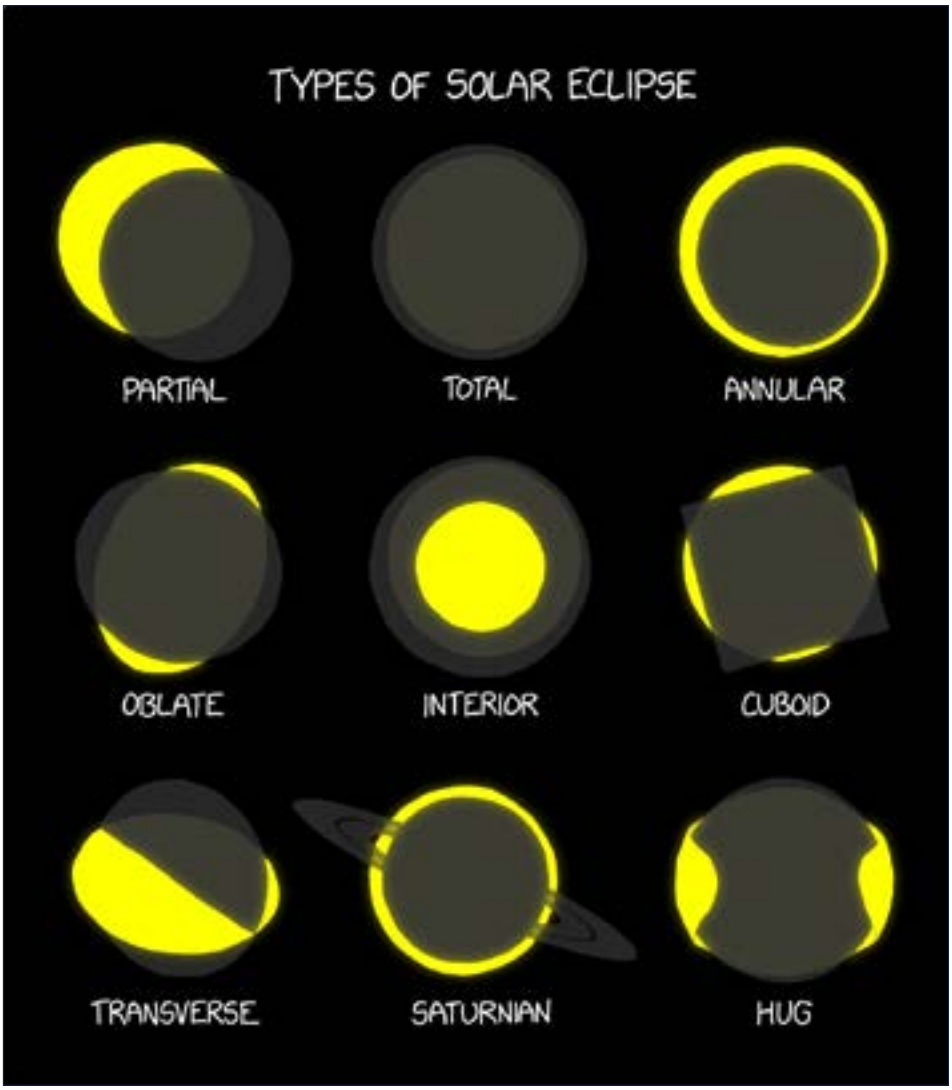
Director & Writer & Photographer Kwon O-Chul Writer Alan Dyer
Music Director Kim Sujin Sound Design Cho Kye Hwan CG Animation Cho Hea Seung, Son Ik Hwa
Science Advisor Jeon Young-Beom, Ahn Sang-Hyeon Production Support KOCCA
CREATIVE SUMM

LAST LIGHT
CHATTING WITH FRIENDS

April S. Whitt
Fernbank Science Center
156 Heaton Park Drive NE
Atlanta, Georgia 30307 USA
april.whitt@fernbank.edu



The best place to be for a hug eclipse is a scenic natural area with good views and few clouds. The worst place to be is the lunar surface. Source: *https://www.explainxkcd.com/wiki/index.php/2816:_Types_of_Solar_Eclipse*

Less than a month to go, eclipse fans!

By now everyone has probably ordered their eclipse glasses, staked out a viewing spot, researched Plans B – Q in case of inclement weather, and dug out the telescope's solar filter. As a handy resource, I offer xkcd's Chart of Solar Eclipse Types:

Or maybe you're one of the brave souls who prefer to wait until the last minute. Or you need someplace to refer visitors with eclipse questions. NASA's web site has a concise list of Q&A: *https://science.nasa.gov/eclipses/future-eclipses/eclipse-2024/faq/*

Planetarium audiences like occasional humor during a presentation. From *https://nj1015.com/top-10-worst-solar-eclipse-jokes-ever/*, you might want to use:

What did the Earth whisper to the Moon about the Sun?
I swear this guy's stalking me; every time I turn around, he's right there.

Why didn't the sun go to college?
It already had like a million degrees.

Looking for a fun family activity with solar filter glasses? If you the time and staff, Mike Toomey's Asterion Foundation has developed templates for making ceremonial masks with the filter material attached for easy viewing. See *https://asterionfoundation.org/sema/* for details.

Visitors to the Balloon Fiesta and Solar Eclipse created masks for safe viewing. Photo by April Whitt.

At the October annular eclipse in New Mexico, our team worked with visitors to construct those masks. The activity engaged all ages, from small children to excited adults. As the eclipse coincided with the Balloon Fiesta, many participants chose the hot-air balloon template.

And finally, when that after-dinner meeting is just about to induce stupor, try making lemonade. Or at least some art.

At the Stars For All conference in June 2023, creativity abounded. This piece: The Persistence of Agenda, organics on ceramic, by Ivy Comer.

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INTERNATIONAL PLANETARIUM'S CALENDAR

COMPILED BY: LORIS RAMPONI

2024

- **15 March.** Planetarium Education Research Fellowship. The IPS Education Committee is delighted to announce the launch of a new IPS Planetarium Education Research Fellowship. The Fellowship offers USD$5,000 (total) to individuals to conduct educational research in planetariums. Specifically the IPS is looking to support research that helps planetarians know how best to use their spaces for educational purposes. Planetariums can be fixed or mobile. Timeline:

  Round One applications: 15 March 2024

  Round One notification of advancement: 30 March 2024

  Round Two applications: 26 April 2024

  Round Two notification of award: 10 May 2024

  https://www.ips-planetarium.org/page/edresearchfellowship

  ...

- **31 March.** Deadline of PLANit Prize for an original video production, organized each year by Italian Association of Planetaria (PLANit), Italy. The prize is open to everyone. First prize 500 euro.
  Contact: *segreteria@planetari.org, www.planetari.org*

  ...

- **8 April.** Total Solar Eclipse (Mexico, USA and Canada). *https://eclipse.aas.org/eclipse-america-2024*

  ...

- **13 April.** 5th Worldwide Meeting online dedicated to traveling planetariums and in particular to operators, producers and sellers. Begin at 02:00 PM Universal Time UTC
  Contact: Susan Button *sbuttonq2c@gmail.com,* Marco Avalos Dittel *info@planetarioaventura.com*
  http://www.ips-planetarium.org/

  ...

- **26-27 April.** WIMPS Spring 2024 Meeting, Paulucci Planetarium, Hibbing, Minnesota (USA) that involve planetariums from Wisconsin, Iowa, Minnesota Planetarium Society.
  Contact: Kevin Milani, *kevin.milani@outlook.com*

  ...

- **26-28 April**. Italian Association of Planetaria (PLANit), Padova Planetarium, National Conference of Associazione dei Planetari Italiani.
  Contact: *segreteria@planetari.org*; Dario Tiveron *dario@fddb.org*
  www.planetari.org

  ...

- 7 May. International Day of Planetariums, 99th birthday of Centennial of the Planetarium
  https://planetarium100.org
  ips-planetarium.site-ym.com/?page=IDP

  ...

- **7 May.** Special event in the Strasbourg Planetarium (France) to celebrate the planetarium centenary. From 6 pm to 9 pm, public tours behind the scenes of the planetarium and screening of the IPS Centenary clip.
  Contact: Wendling Milène, milene, *wendling@unistra.fr*

  ...

- **7 May.** Astronomy Day. Astronomy Day is a world-wide event designed to celebrate all facets of astronomy. *https://www.astroleague.org/astronomyday/news*

  ...

- **18 May.** International Museums Day, *http://icom.museum*

  ...

- **4-6 June.** 9th Fulldome Festival Brno. It will again offer its visitors with the newest content on the fulldome market from all around the world, Brno Observatory and Planetarium, Brno, Czech Republic
  fulldomefestivalbrno.com
  Contact: *director@fulldomefestivalbrno.com*

  ...

- **5-8 June.** European Network Science Centres & Museums (ECSITE), Annual Conference, Kersnikova Institute, Ljubljana, Slovenia.
  https://www.ecsite.eu/conference

  ...

- **30 June**. Asteroid Day. *https://asteroidday.org/*

  ...

- **17-19 July**. ZEISS Experience Days, "The Power of UNIVIEW", Carl Zeiss Jena GmbH, Jena, Germany.
  Contact: *andreas2.schmidt@zeiss.com, www.zeiss.com*

  ...

27th International Planetarium Society Conference, Berlin-Jena, Germany.

- **17-21 July**. Pre-Conference Activities (Fulldome Festival, IMERSA Day, and LIPS Day).
- **21 July.** Gesellschaft Deutschsprachiger Planetarien e.V., (GDP), Annual Conference of the Society of German-Speaking Planetaria, Berlin.
  Contact: *bjoern.voss@lwl.org*
  www.gdp-planetarium.org;

  ...

- **21-25 July.** IPS Conference.
- **26-28** July. Post-Conference Tours.
  Contact: i*ps2024@planetarium.berlin*
  https://www.planetarium.berlin/ips2024

  ...

- **31 July.** Deadline for applications for "Two weeks in Italy"

CENTENNIAL OF THE PLANETARIUM

Get Ready

Join us in celebrating the Planetarium's Centennial.

Numerous activities in preparation for and implementation of our anniversary are now entering the hot phase. Be part of it and join us in using the anniversary as a platform for our important messages:

- Planetariums are essential for conveying a scientifically based view of the world.
- Planetariums require promotion and support, politically and from society and industry.
- Planetariums reflect extremely important socially relevant topics.
- Planetariums are state-of-the-art facilities and offer contemporary immersive experiences.

Take part in the **poster and fulldome clip contests**! Encourage graphic designers and producers to enter the contests (deadline: September 1, 2023).
Find your matching **Supplementary Package for Planetariums** containing Educational and Marketing Kits for the anniversary! Send orders to info@planetarium100.org.

Visit the Centennial website for more information: **planetarium100.org.**

IPS INTERNATIONAL PLANETARIUM SOCIETY

The Stars were just the Beginning

GDP

organized, with the support of International Planetarium Society, by PLANit in collaboration with IPS Portable Planetarium Committee and Serafino Zani Astronomical Observatory.
Contact: Susan Reynolds Button, *sbuttonq2c@gmail.com*
http://www.ips-planetarium.org/
...

- **25-27 September.** Association of French Speaking Planetariums (APLF), Annual Conference, Planetarium of the University of Strasbourg, France.
Contact: Wendling Milène, milene, *wendling@unistra.fr*
www.aplf-planetariums.org
...

- **28 September -1 October.** Association of Science and Technologies Centers (ASTC), annual conference, Museum of Science and Industry, Illinois, USA.
https://www.astc.org/
...

- **16 October**. Brno Observatory and Planetarium, Czech Republic, celebrates its 70th anniversary on October 16th, 2024.
...

- **31 December**. Deadline for the contest "A week in United States" For information and application requirements go to: *www.ips-planetarium.org/?page=WeekinUS*
...

- **31 December**. Deadline of the prize "Page of stars" organized by IPS Portable Planetarium Committee in collaboration with Serafino Zani Astronomical Observatory.
Contact: Susan Reynolds Button, *sbuttonq2c@gmail.com*
http://www.ips-planetarium.org/?page=pagesofstars
...

2025

- **7 May**. International Day of Planetariums, 100th birthday of Centennial of the Planetarium
https://planetarium100.org
ips-planetarium.site-ym.com/?page=IDP
...

2024 PLANETARIUM ANNIVERSARIES

70 years

- Brno Observatory and Planetarium, Czech Republic, celebrates its 70th anniversary on October 16th, 2024.

60 years

- Abrams Planetarium in East Lansing, Michigan, USA, is celebrating its 60th anniversary. The building was completed at the end of 1963 and it was dedicated and opened it's doors February 1964. A large birthday party with the public has been held in February.
- Planetarium Bochum, Germany
- Zeiss-Planetarium Vienna, Austria

40 years

- Planetarium Mannheim, Germany

The First Theories (con't.)

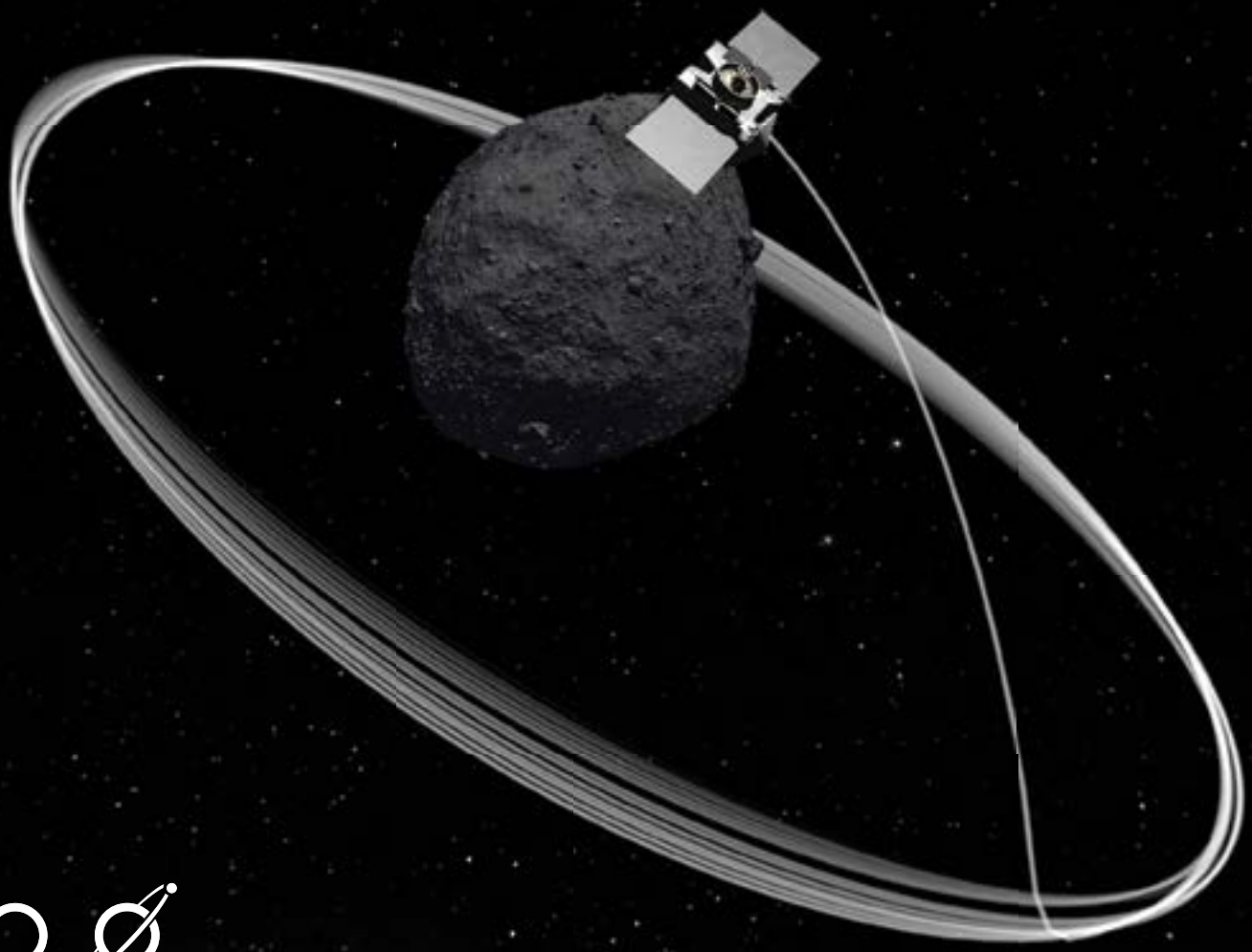
flows, a mechanism described in 1957 by Eugene Parker by introducing the expression "solar wind".

From 1958, Mairan's hypothesis of a contribution of solar matter was thus validated, with a two-century gap, by the advent of space astronomy making it possible to observe this solar wind with artificial satellites in orbits. eccentric, taken up for the Themis mission, and the observation of polar auroras on other planets such as Jupiter and Saturn.

It now appears as a precursor of the new physics of Sun-Earth relations, a branch at the intersection of solar astrophysics and the geophysics of the upper atmosphere. Of course, this is the solar origin of the global aurora borealis phenomenon. Due to the configuration of the Earth's magnetic field, the auroras visible at low geomagnetic latitudes (below 47°) are not caused by direct interaction with solar wind jets, but by shock waves replicating the interaction. produced in the polar magnetic tube.

Studied by Josiah Morton Briggs in 1967, Mairan's ideas on this subject were the subject of an official rehabilitation by the Academy of Sciences, through an article by Jean-Pierre Legrand, astrophysicist, in La Vie des Sciences en 1985, which qualifies him as "the founder of a new physical conception of the relations between the Sun and the Earth, other than that resulting from universal attraction" by attributing a dynamic role in the origin of the auroras to what he designates "the atmosphere of the Sun". Legrand emphasizes that the most important aspect of his work, the true starting point of his theory, is to have established a first correlation of the recurrences of the aurora borealis with the increases in brilliance of the zodiacal light.

Bring space to life



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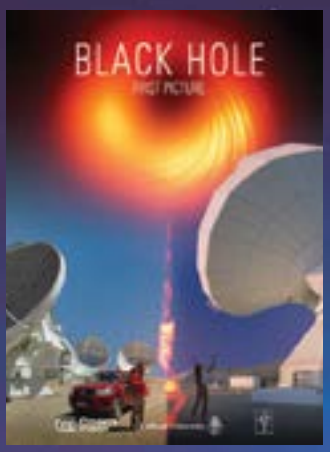

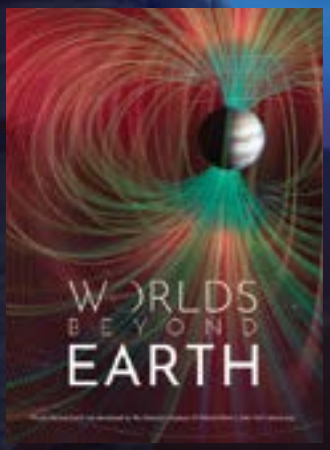

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