Planetariums - Beyond the naked eye

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Abstract

The night sky visible to the naked eye, whether seen from a dark site or inside a planetarium, is unfortunately a very shallow view of the universe. One can barely make out our Galaxy. There is a great need to reveal to planetarium audiences the nature of our Galaxy and how galaxies such as ours are sprinkled throughout the visible universe, within a world bounded by the shell formed by the Cosmic Microwave Background. One way of doing this is to resort to full dome video, such as was done in the re-opening of New York's Hayden Planetarium, but this requires a large budget. Alternatively, 'all-sky' images, projected in register with the planetarium star field can show us what the eye cannot see. Furthermore, the software and databases used to make the New York production are now available in a form that can be run on a almost standard pc.

Paper

We humans have evolved as creatures of daylight. Our eyes, our main sense organs, work well in a daytime environment. Daylight is so abundant that the entrance aperture to our eye is usually only a millimeter or two across. We can adapt to nighttime, but only to a limited extent. The aperture can increase to 6 or 7 millimeters and in the same time span as normal twilight, the production of rhodopsin switches vision from cones to rods. Rods are the more abundant and more sensitive of the photoreceptors in the retina of the eye. We can see fainter light levels with them, but only in black and white and with limited resolution. Suffice to say that if we were to walk the countryside at night, we would frequently stumble over tree stumps and rocks that we could not clearly see. In modern times, we would be lost without artificial lighting.

Yet at night, we use our eyes to look up and examine the universe that surrounds us. Not surprisingly, we do not see that much. Of the seven other major planets in the solar system, the naked eye can make out five. Of a trillion stars in the galaxy, the eye sees at best only about nine thousand, none of them particularly distant. It has no way to discern the true shape of the galaxy, which it sees as a vague luminous blur. Of all the billions of other galaxies in the observable universe, it can just manage to see only three.

It is a very shallow view of the universe! No wonder so few people realise what is out there, or even know where they are.

It is the same shallow view that we attempt to reproduce on our planetarium domes for the benefit of the public. And the problem is the same. Most members of the public cannot interpret what they are seeing. Of course, it is the planetarian's job to provide that interpretation. But if all they have to show is the normal star field that a planetarium projector provides, then a lot of explanation and vivid description is necessary.

Why then can a planetarium not show the audience where they are? It seems the most fundamental need that ought to be addressed. In fact, it was exactly what the opening production of the new Hayden Planetarium in New York sought to do. But few of us have all-dome video and the budget that that lavish production required. However, many planetariums possess six-projector 'all-sky' systems and such systems can be employed to do the job.

We simply need to show the Galaxy in which we live. Once the audience can understand the nature of our Galaxy, they can extrapolate that knowledge to other galaxies. So we need to enhance the sensitivity of the human eye, such that it could see the sort of details recorded by astro-photography, so that it could clearly see the nature of the Milky Way.

At the planetarium in Cape Town, we have, since 1989, been trying to show our audiences what the Milky Way is like. The idea has been to produce artwork (based on astrophotography) that could be put up by the 'all-sky' projectors (6 wide angle projectors that together cover the whole dome) in place of the diffuse Milky Way projected from the star projector. In other words, the artwork would work in register with the stars from the star projector, and be projected at an appropriate intensity level. We have been through three different versions of the Milky Way 'all-sky' scene (with artwork painted by Anina Botha and Margie Walter), each one an improvement on the previous version, the last involving two banks of all-sky projectors.

This artwork has however been completely 'eclipsed' by the recent release of a colour photographic panorama of the Milky Way prepared by Axel Mellinger, based on 51 photographs of the night sky taken from various dark-sky locations in California (USA), South Africa and Germany. Azimuthal versions of this digital image can be adapted for the planetarium all-sky system. Mellinger has also prepared a modified version, with all bright stars (<6m) removed by appropriate software, which works in register with a planetarium starfield. The traditional star projector has a clear advantage in displaying pin-point star images, while the photographic panorama offers a unique view of the Milky Way's star clouds and nebulae.

The Milky Way all-sky is clearly the most crucial visual for demonstrating where we are in the universe; it can also be used as a staging point to the extragalactic universe. The author being a researcher in galaxies has, in previous years, developed an extragalactic sky, which shows the positions of several thousand nearby galaxies, rather than stars, via the all-sky projectors.

A complementary approach is to show what the eye cannot see because it is outside the visual portion of the electromagnetic spectrum. Again in the past, all-sky projectors have been used to put up a false-colour radio sky (more specifically that at 2300 MHz from Rhodes University). Such a scene is dominated by the Milky Way, but includes numerous extragalactic sources. We also plan to work on 2MASS data to show the sky and the galaxy in the infrared.

One can also show the ultimate horizon – the surface of 'last scattering' of the early opaque universe – the Cosmic Microwave Background. That surface encloses the observable universe in a spherical shell, so it is very appropriate to depict it on the hemispherical screen of the planetarium. In the past, we have used the well-known COBE data, but its resolution has now been far exceeded by the BOOMERANG data. The latter does not however cover an entire hemisphere, so some license has to be taken. Future years will see data from the MAP spacecraft.

An alternative method of showing an audience 'where we are' in the universe is now possible by means of the 'Digital Universe' and 'Partiview' software freely available from the Hayden Planetarium (www.haydenplanetarium.org), derived from the material used for their opening production mentioned above. This no longer requires a planetarium for viewing, but its content is of course very appropriate for a planetarium setting.

All in all, current technology allows much to be done in conveying to planetarium audiences a much clearer picture as to where we are situated in the Galaxy, where our Galaxy is situated, and what we actually see when we look into the night sky.