# Visualising Astronomy: "The Big Picture"

Reviews

**Ryan Wyatt**
California Academy of Sciences
E-mail: rwyatt@calacademy.org

**Key Words**

Visual Communication
Astronomy Visualisation

News flash! Planetariums have changed. With fulldome video technology in nearly 700 planetariums worldwide, these "theatres of time and space" have evolved into learning environments that truly deserve that moniker. How do we teach with these new tools, these new images? And what potential do planetariums now offer for changing the way people think about humanity and its place in the Universe? A few personal observations and speculations follow...

One can think of planetariums as offering two kinds of "big picture." First off, a domed theatre often projects an intrinsically large image: the Morrison Planetarium sports a 23-metre-diameter dome, with a correspondingly enormous projection. But modern planetariums also allow for an opportunity to present nested spatial scales out to the Cosmic Microwave Background (CMB), scaffolding each hierarchical step in a fundamentally visual and visceral experience, a gateway to big-picture thinking. We in the biz usually refer to the latter under the umbrella term, "the Digital Universe," a name coined by the Hayden Planetarium team at the American Museum of Natural History, USA.

As a couple of colleagues and I wrote more than six years ago, "The Digital Universe atlas has grown out of a convergence of two great streams of technical achievement: celestial mapmaking, the product of centuries of observation and scientific breakthrough, combined with hardware and software engineering, which enables sophisticated data visualization." In closing, we speculated that, "perhaps the Digital Universe can help stimulate a cosmic perspective toward our own species." With several more years of experience under the planetarium community's collective belts, we have gained significant experience working with the Digital Universe, but we still have a lot to learn.

A three-dimensional virtual model lends itself to talking about scale, and indeed, most teaching with the medium has cantered on conveying the immensity of the Universe. Light travel time of course becomes the lingua franca of describing distance, and maximizing impact with an audience, one can link time to events in a person's life—or events in the history of life on Earth. The distance to the Moon? One and a half seconds corresponds to a brief pause in conversation. Between Earth and the Sun? Eight and a half minutes might afford enough time for a quick lunch. The diameter of Pluto's orbit? A good night's sleep. The nearest star? A high school or college education (in the United States, at least). Across the Milky Way? The history of our species on the planet.

Sometimes, the temporal and physical scales mesh perfectly to reinforce conceptually important points. For example, the concept of the "radio sphere" has entered the vocabulary of many people who talk about the Digital Universe: a sphere 70-some-odd light years in radius, which represents the distances out to which humanity's strongest radio signals have travelled. "Before television carrier waves, early-warning radar first used in World War II, and the detonation of atomic weapons, Earth was radio-quiet to the Universe. After the use of these and other radio emitters began, in the late 1930s and early 1940s, signals were able to escape the atmosphere and travel into space at the speed of light."

These examples speak to a critical point in helping audiences make sense of the size of the Universe. Connecting human experience to otherwise abstract data

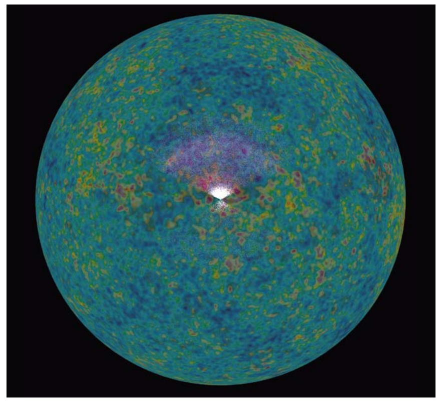

*Figure 1. Earth's radio sphere (the small blue circle near the centre of the image) in context with a two-dimensional spiral galaxy image scaled to the size of the Milky Way, rendered using the Partiview freeware. Courtesy of AMNH/NCSA.*





allows people to make the concepts more concrete—and more approachable. When one looks at an image of the radio sphere appropriately scaled relative to the size of (a stand-in for) the Milky Way, one sees humanity's electromagnetic footprint in space (Figure 1). It also represents a relative technological timeline: if the Milky Way's diameter corresponds to the age of *Homo sapiens*, then the radio sphere represents the duration of one of our species' technological attributes. The spatial and temporal scales overlap in a meaningful, visual way.

Of course, this only gets you so far. By the time you hit the Virgo Cluster, you're talking about the death of the dinosaurs, and the scale of light travel time becomes fairly abstract. And of course, the billions of light years that separate us from distant quasars represent a period over which the Universe has changed dramatically. The ultimate punch line is the CMB placed in context with the galaxy and quasar distances measured by, for example, the Sloan Digital Sky Survey (Figure 2). Looking out in space means looking back in time, and the use of light travel time as a measure of distance eventually leads to a head-on confrontation with evolutionary changes in the Universe.

A written explanation of this journey does not communicate the impact of virtual travel afforded by a contemporary planetarium. Technological and aesthetic choices transform this intellectual journey into a visual experience. Indeed, in a modern planetarium, "flying" through a virtual model of the Universe, it becomes a truly visceral experience: you can feel exhilarated and perhaps even a little queasy making the trip out to the CMB.

## What does this kind of cosmological thinking inspire?

For many, frankly, a certain amount of frustration. After taking people on a "tour of the Universe," I often get asked what things look like "right now": people grasp the idea that light travel time reveals objects as they existed in the past, but they find it difficult to divorce the three dimensions of the virtual model from the three dimensions of ordinary space. (Whereas the virtual model actually combines spatial and temporal dimensions, and of course, the finite speed of light allows us to reconstruct the history of the Universe, effectively embedded in the three-dimensional representation.) Overall, one can leave such an experience feeling very small...

But perhaps we can use the "big picture" to evoke other responses. Perhaps placing Earth in its spatial-temporal context can redefine how people think about their home planet. One could think of this as an extension of the "overview effect" reported by astronauts, in which the experience of seeing Earth from space invoked feelings of connectedness and euphoria. Can such a response be elicited virtually?

My institution, the California Academy of Sciences, USA, does active research in the life sciences as well as outreach, and for a grand re-opening in a new, green building, astronomy played a supporting role in a planetarium show that knitted together the themes of the Academy's exhibits and research. *Fragile Planet* placed Earth in a cosmological context, with the intention of influencing audiences' ideas about environmentalism and sustainability. Our as-yet unpublished evaluation of the program showed that audiences got that message, but not as loudly and clearly as intended.

Perhaps such connections require more specific emphasis. The Academy recently hosted a meeting for the NOAA-funded Worldviews Network team, and we spent an evening in our GeoDome strategizing. In the words of the proposal statement, "the Worldviews Network will make explicit the interconnections of Earth's life support systems across time and space" with the goal of "engaging the American public in dialogues about human-induced global changes." To paraphrase my colleague David McConville, a cosmological perspective might help open people's minds to the magnitude of the design challenges that face us in a rapidly changing world.

How might the Digital Universe transform people's views? The current generation of planetariums, equipped with appropriate technology and data, might just open people's minds to new attitudes and understanding.

*Figure 2. The Observable Universe seen from outside in both space and time: WMAP data depicted as a sphere cantered on Earth with SDSS galaxy (white and red) and quasar (purple) data scaled accordingly, rendered using the planetarium software Digital Sky. Courtesy of M. SubbaRao (Adler Planetarium) & D. Surendran.*

## Notes

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**Biography**

**Ryan Wyatt** is the Director of Morrison Planetarium and Science Visualization at the California Academy of Sciences in San Francisco, California, U.S.A. He writes a sadly irregular blog, "Visualizing Science," available online at http://visualizingscience.ryanwyatt.net/.