

SYMMETRY AND COLOUR IN ART AND SCIENCE

DAVID MALIN

Name: David Malin, Astronomer (b. Bury, England, 1941)

Address: Anglo-Australian Observatory, P.O. Box 296, Epping, NSW 2121, Australia
and Royal Melbourne Institute of Technology, Melbourne, VIC, Australia

E-mail: dfm@aaoepp.aao.gov.au

Fields of interest: Astronomy, photography, colour (music, politics).

Awards:

- Fellow of The Royal Photographic Society, 1983.
- Henri Chretien Award of the American Astronomical Society, 1985.
- Jackson-Gwilt Medal and Prize of the Royal Astronomical Society, 1985.
- Doctor of Science (Honoris Causa) from the University of Sydney, 1989.
- Rodman Medal of the Royal Photographic Society, 1990.
- Honorary Fellow of the Australian Inst. of Prof Photography, 1993.
- Progress Medal of the Photographic Society of America, 1993.
- Commonwealth Medal of the Australian Photographic Society, 1993
- University of NSW Press/Eureka Science Book Prize 1994.
- Adjunct Professor of Scientific Photography at RMIT, 1996
- Fellow of the International Academy of Astronautics, 1998
- Lennart Nilsson Prize, 2000.

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and [HTTP://WWW.AAO.GOV.AU/images/general/scipap.html](http://WWW.AAO.GOV.AU/images/general/scipap.html)

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Abstract: Symmetry abounds in nature but often it is obscured, sometimes in subtle ways. Uncovering these hidden linkages is usually fundamental to understanding them, so it is an integral part of science. Nowhere is this more true than in astronomy, where its practitioners also have to come to terms with a universe that is mostly invisible to the eye and is never seen in colour. However, colour is another powerful diagnostic that is similarly central to art as well as science. In this contribution I hope make some connections between art, science and the ancient search for meaning.

1. ART AND SCIENCE

Symmetry underlies many of the ways we think about both art and science. Of the four dimensions which we normally use to define the world we live in (up and down, in and out, left and right and time), only time is inherently asymmetrical, moving relentlessly forward, never back. Thus if we know the spatial properties of one half of an object we can infer (in science) or anticipate (in art) what the other half may be like, even if it is unseen or inaccessible. This principle applies universally in science and widely in the visual arts, in poetry and in literature and especially, in music.

Also important in understanding the worlds of science and art is colour. While artists and scientists see the same colours their interpretation and motivation for understanding them is entirely different. The gulf between the two groups is nowhere broader than in the discussion of colour. In a neatly symmetrical way, as important as symmetry is its opposite, asymmetry. Perfect symmetry is beautiful, but it is also sterile. If the universe had failed to develop asymmetries billions of years ago we would not be here to admire it. In art it is often the departures from symmetry that are aesthetically pleasing or disturbing and in science those same asymmetries are both revealing and informative.

To the artist colour is a means of expression, and that expression can convey mood as well as a state of mind. Artists talk of complimentary colours as though there were real symmetries in the concepts and they are familiar with colours that convey warmth or distance. While scientists are not impervious to these feelings, in the science context colour is simply another diagnostic tool, providing more information about life and light.

These reactions to colour and to symmetry seem superficially opposed, but they are profound links that hint at the shared origins of art and science, which are buried deep in the human need to know and to understand. Thus the core cultures that underpin our society spring jointly from some in-built aesthetic and from curiosity, the restless urge to explain and to explore that is in all of us. These characteristics, along with some compassion and perhaps a sense of humour are what make us human. But that's another question.

1.1 An astronomical perspective

Though time is completely asymmetrical, moving ever forwards, astronomers are fortunate in being able to look back in time. This is because the travel time of light, though very rapid, is not instantaneous. Thus very distant things are seen as they were long ago, and the most distant things we can see existed billions of years ago, when the universe was tiny fraction of its present age.

Here lies the greatest application of symmetry, the assumption that on the largest scales the universe is both homogeneous and isotropic, in other words, that the ingredients are thoroughly mixed and uniformly distributed. This 'universal symmetry' is one of the basic ideas of modern cosmology. Like most cosmological ideas it is incomprehensible to mere mortals. Common sense tell us that the ingredients of the universe are not well mixed and they are not evenly distributed. You only have to look out of the window to see that. And asymmetries in the early universe, long anticipated and only recently discovered, are reckoned to be the first signs of the structure we see when we make three-dimensional maps of the distribution of galaxies we see today.

Such gigantic structures do not trouble cosmologists, and they argue that on the grandest scales the universe looks the same in all directions. cosmologists are fortunate to have a huge canvas on which to expand their ideas and a very broad brush with which to paint them. Another aspect of the universe that is hidden from view is colour. Again, this remark is incomprehensible to anyone looking out of their window. Our daily life is filled with colour. But we live in an unusual place, on a rocky, wet planet, surrounded by a protective atmosphere and just close enough to a modest, well-behaved star. The star is the Sun and its light is bright enough for our visual system to see our immediate surroundings in full colour. Almost everywhere else in the universe this is not true. If we take a telescope and look through it at the distant stars, galaxies and nebulae are essentially colourless. Analysis of this feeble light shows that colour is there in abundance but it not seen because the eye is insensitive to colour when light levels are low.

It is no accident that the language of astronomy is full of phrases such as 'redshift' and 'blue shift', black holes, brown dwarfs and red supergiant stars. The ideas of colour are embedded in their thinking, but only as abstract ideas. Astronomers rarely visualise these colours, and to most people the light from a red supergiant star would be no redder than the tungsten lamp in your living room. So we are in a sense protected from the two aspects of nature which are so important in our everyday lives—the symmetry that tells us about the hidden laws that govern the way the universe is constructed, and colour, an essential diagnostic for those things we cannot smell, hear or touch.

Among the fundamental particles of matter symmetry dominates and colour has no meaning. Some theoretical developments of "superstring theory" suggest that there may be a "theory of everything" that will provide a single underlying description incorporating all matter, all forces, and the nature of space and time. A basic ingredient of such theories is the idea of 'supersymmetry', a relation between the types of fundamental particles associated with matter and those associated with forces such as gravity. If these supersymmetries did not exist, the story goes, matter as we know it would not exist so none of this would matter, so to speak. However you look at it, symmetry is at the heart of our scientific understanding of the universe in which we live.

1.2 Symmetry and colour in the real world

Symmetry and colour in the visual arts is nowhere more refined than in the Islamic World. My wife and I recently visited Cordoba, a center of intellectual life in Spain since Islamic times 1000 years ago. We were also in nearby Grenada, whose art reaches a pinnacle of perfection in the exquisite Alhambra Palace, overlooking the city.

Despite its conversion to a Christian church, the interior of the mezquita, or mosque in Cordoba is so beautiful that it took my breath away. I was moved almost to tears by its visual power. The impact comes from the apparently endless rows of double arched columns that seem to extend infinitely beneath a richly ornamented roof. In an inspired piece of artistry, the components of the arches are made of alternating grey stone and red tile sections. The columns are evenly spaced, and as one moves between them new patterns materialise, each one offering a new perspective on the striped arches. through them on glimpses a ceaseless array of subtle yet vital shifts in colour.

Such sights make one ponder on the nature of civilisation itself. The Muslims completed their mosque over 1000 years ago. It is so enormous that 400 years later the Christians were able to build their cathedral inside it. Though they changed its character by doing this, it is significant that they did not destroy the Muslim architecture. If only such religious tolerance survived today.

The endless variety that meets the eye in the mezquita-cathedral of Cordoba is the result of almost 900 columns and the arches they support being placed in regular rows. As one walks slowly through them, mesmerised by the richness and complexity of the scene and oblivious to hundreds of tourists, long sight-lines of columns suddenly appear and just as quickly vanish, followed by others at different angles in restless profusion. The striped arches line up along different sight-lines at different angles in a display of delicate but sensual colour contrasts. And then it struck me. I was inside something resembling a life-sized crystalline structure and the long sight-lines represented the multiple planes of symmetry that make crystals what they are.

To an artist this may seem a dry and uninteresting way of looking at something so stunningly beautiful, but to a scientist (and a long-lapsed X-ray crystallographer at that) this kind of experience links art and science in a very intimate way. It is also extremely rewarding for both sides of the brain, an organ that is itself outwardly symmetrical and inwardly polarised. But again, that is another story.

The Muslims contributed greatly to the knowledge that grew into western science and to our aesthetic appreciation of the world. To them there was no schism between art and science. They were one, and so it is today.