2D is 3D

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Dimensions are the critical reality we all take for granted. Nevertheless, dimensions are critical for reality itself. We are herein going to explore dimensions in general – and dimensions that astronomers experience.

Dimensions in General

Fish swimming deep in the sea don't contemplate water and wetness, unless they swim to the surface air. Otherwise for them water = reality, as wet is in all directions. Why should they think otherwise? If a fish had the ability to contemplate very much the reality of dimensions in water, or life on land – that fish could be less successful in basic feeding, surviving, and procreating.

Humans are cursed with curiosity. It is our greatest strength, and potentially our greatest weakness. We were long ago curious about burning carbon for heat and engines, and recently curious about building nuclear bombs. You know the rest.

Euclid's *Elements* starts with the idea of a point, axiomatically defined as a dimensionless position in fixed space which has no parts. From points Euclid logically extended things with lines having no width. Then he joined lines to create plane geometric figures in 2D. Only in Books XI–XIII did he discuss solid geometry.[1]

[1] https://www.britannica.com/biography/Euclid-Greek-mathematician

The next step would be analytic geometry and Cartesian three dimensions. Euclidean geometry is a synthetic geometry, going from axioms to propositions without coordinates. Analytic geometry has coordinates.

Here's the fundamental problem at the core of Euclid and classical geometry: Lines in planes are defined as strings of points with no width joined together. Since individual points have zero length, even an infinite number of joined zeroes still only equals zero. Therefore, according to Euclid's own axiomatic logic, Euclidean lines cannot exist. If there are no lines, there can be no plane geometric figures created by joining lines. You also can't simply join non-existent lines to create 3D shapes.

There can be no 2D without 3D – except in a Platonic idealistic way where actual points do not exist, but ideal lines and figures do. Even then 2D does not replace the need for 3D. Plato's *Republic* features the allegory of the cave.[2] Ironically, this cave allegory has both inspired modern ideas of a holographic universe, and provides its best critique.

The "best" response mathematicians have advanced for this problem is to say that math itself is primary reality, and what we think is real is just math. This is the general version of Plato's envisioned idea of perfect geometric forms in the sky.

A "point" within three math dimensions can be imagined as a tiny sphere with zero dimensions, which is truly imaginary for reasons explained in the preceding paragraphs. Nevertheless, two dimensions in the real world require three-dimensional depth to transform from pure idea to existential reality. In other words, 2D in the real world requires 3D. 2D is really 3D.

We can mark a piece of paper with a pencil, drawing what seems to us as a one-dimensional line. We can doodle as we please, and it looks *from above* like 2D. This self-delusion works

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[2] http://historyguide.org/intellect/allegory.html

only when we forget that pencils leave 3D layers of graphite on top of the 2D surface of a 3D piece of paper, and such lines have the width of the pencil mark. Even using ink that soaks into paper does not allow us to get around the problem, as the paper has a 3D thickness that absorbs the ink, not just a 2D surface to hold 2D graphite. Looking down from above is itself a third dimension and frame of reference.

In addition to the classical three dimensions there is the fourth dimension of time, which is photon vectors. In General Relativity that 4th dimension is combined with the others to become spacetime. In Cartesian coordinates (x,y,z) it is possible to arbitrarily designate any static three-way intersection as the preferred point of reference, giving a three dimensional frame of reference. More realistic is the 4D velocity frame of reference, Einsteinian or Newtonian.

In the early 21st century there are many bright theoretical astrophysicists who are brilliantly confused, competing with different equations. These equations have idealistic lives of their own, being solipsistic and internecine. None of them would get past Kurt Gödel's incompleteness theorems.[3]

The greatest apparent problem is the great divide between General Relativity and different quantum theories at the smallest scales, where cross pollination of equations leads to absurd zeroes and infinities. Einstein went to his grave in 1955 tormented by permutations of the very quantum ideas that helped him win a Nobel Prize.

In our "peer reviewed" world some of the weirdest ideas get wide publicity in the fawning general science press: Among them are supersymmetry[4] (which has never been verified); multiple

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[3] https://plato.stanford.edu/entries/goedel-incompleteness/

[4] http://astronomy-links.net/supersymmetry.htm

dimensions far beyond 4D[5]; turning 2D membranes/branes into geometric gravity[6]; dark energy[7]; and so forth.

The current psychedelic crown belongs to ideas of the universe being a hologram.[8,9] A similar idea holds that immediately inside event horizons of black-holes negentropic energy is not lost, just deposited in holographic fashion.[10] If a serious theorist outside the astrophysics club had initially published any of these ideas, he or she would have been labeled a crackpot, and for good reason.

Dimensions in Observational Astronomy

We now turn to the familiar world of observational astronomy, which is seemingly far removed from the astrophysics game. I have been a serious amateur astronomer since I was ten, and have owned several telescopes, including a large Dobsonian with tracking motors. During this time I have become aware of the need to focus on experiencing the 3D aspects of 2D observing.

In prehistory, humans imagining themselves at the center of everything looked up at night from their perceived flat Earth, and gazed in amazement through pristine skies at all the sparkling firmament above. The stars moved in concert; but some brighter objects wandered, which is the origin of the modern word, planets. Most amazing were the Moon and the Sun. By default the Sun became the supreme sky god, as well it should be. Everything had a sublime cyclical order, with personal gods and supernatural forces all around. Only much later was Galileo's

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5 https://en.wikipedia.org/wiki/Dimension#Additional_dimensions

6 http://astronomy-links.net/LIGO.and.GR.pdf

7 http://astronomy-links.net/DipoleRepellerExplained.pdf

8 http://astronomy-links.net/Holograms.html

9 https://www.wired.com/2015/12/universe-not-yet-found-to-be-a-hologram-bummer/

10 http://astronomy-links.net/hawkingerrors.html

telescope, looking at Venus, able to correct some of this self-centered fantasy.

Amateur astronomers are almost like a priesthood of the real. The heavens link us to what and where we all exist in the big picture. Seeing how dimensionally small we are in relation to galaxies in the sky does not make us essentially small. It makes us cosmic members of a much larger unity. Astronomy gives us hope for the future, and a sense of proportion. Plus, sky gazing is a beautiful experience by itself. How sad it is that modern people living in big, polluted cities can only see a very few bright astronomical objects. Air pollution kills cosmic dreams, as well as our health.

Universal consciousness emerged from the realization that the previously believed nearly 2D "dome" above us is actually a perspective illusion, whereas deep 3D is reality. Galileo gave us a vision of glory much more exquisite than any institutional sky god could provide. That's why the priest Giordano Bruno was burned at the stake in 1600, just four decades before Galileo showed us the phases of Venus. Galileo himself could have been tortured or burned at the stake, rather than put under house arrest, if he had not been a personal friend of the pope. Galileo gave us real science, and reactionary religion gives us fake science.

If you desire to better envision from your amateur observation location the three-dimensionality of the starry firmament, here are some ways to perceive what really is up there:

(1) Our natural 3D vision is given by the separation of our two eyes, about three inches. This narrow triangular base means our true 3D vision is only good for near things that mattered to prehistoric hominids. Looking at objects in the sky through any telescope is a 2D visual experience, even using binocular telescopes. Looking at heavenly objects through binoculars in focus is 2D, since the separation is about equal to that of our natural eyes. Thus we need perception to supplement vision.

(2) Ancients easily believed the stellar dome was without much depth. They could not imagine what depth they were seeing. M31 was just another fuzzy patch nearby. Giordano Bruno was incinerated because he sacrilegiously said stars are distant and like our own, with planets and creatures like us. We prefer our gods to be personal and close – like on Mount Olympus, or personal in our Hindu homes, or like the god/man Jesus.

(3) Bruno *expanded the idea of god*, and that was his genius crime. Placing the Earth at the geometric, anthropocentric center of "creation" had seemed proper, and it worked for institutional religions. Telescopic astronomy gives us a much grander idea of the firmament, an envisioned 3D perspective, and potentially a grander idea of god. It is with some irony that the Roman Catholic Church formally apologized in 1992 for how they treated Galileo, 350 years after his death.[11]

(4) Three dimensions are associated with four dimensions when there is perceived radial velocity. We cannot perceive within human time the most distant celestial objects moving about. However, there are ways to measure distance.[12] Close in, there is Earth-orbital parallax, generating parsecs (1 pc = 3.26 light years).[13] That's only good for depth gauging fairly near stars.

In the late 18th century Cepheid variables were discovered, pulsating stars that vary in their luminosity according to the frequency of their cycles. In 1923 Edwin Hubble found a Cepheid variable in M31, the Andromeda Galaxy. That star gave him a standard-candle distance of about two million light years, proving that this "spiral nebula" was not associated with the Milky Way.[14]

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[11] http://4thefirsttime.blogspot.com/2007/09/1992-catholic-church-apologizes-to.html

[12] https://en.wikipedia.org/wiki/Cosmic_distance_ladder

[13] https://en.wikipedia.org/wiki/Parsec

[14] https://en.wikipedia.org/wiki/Cepheid_variable#Use_as_a_.22standard_candle.22

For really great distances we now use Hubble's law to measure Doppler shifts in distant light spectra. Therefore, even though we cannot directly detect with our eyes such distances, even using telescopes, we do have fairly reliable measuring tools to help us appreciate the vast distances within what used to be a nearly 2D "dome."

(5) A sharp eye can make major 3D discoveries at the telescope. In 1965 Halton Arp discovered a line across the spiral disk of galaxy M81 in Ursa Major. For years it was known as Arp's Loop, and thought to be a result of gravity tugging on M81 by the nearby M82 galaxy.[15]

In 2010 an association of astronomers at several universities concluded that this loop is part of our own galaxy's Integrated Flux Nebula, or galactic cirrus layer several hundred light years above the Milky Way's plane. I separately had made the same discovery visually in five minutes.

These academics published their IFN conclusions, missing the real jewel: They did not discover that Arp's Loop is part of the foreground expanding shock wave from an old stellar nova inside our dusty cirrus. That's like finding a real Easter egg, and missing the chicken. There are many similar smoke-ring-like nova remnants in our galactic cirrus. One appears only a few 2D degrees away from the much more 3D distant Polaris. It appears in the APOD image as a wobbly ring above Polaris, and a faint meteor appears there too.[16]

(6) I recommend that you explore the nearly 8,000 awesome Astronomy Picture Of the Day (APOD) images on the web.[17] These often vivid images come with descriptions, and typically

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[15] http://astronomy-links.net/arpsloop.html

[16] https://apod.nasa.gov/apod/ap110514.html

[17] https://apod.nasa.gov/apod/archivepix.html

additional links. Then go out and locate some of them. You will find less visually impressive faint fuzzies in your eyepiece, but also be "seeing with your mind" the depth perspective that the APOD image and discussion have taught you. It's fun to do this. Your direct and personal encounters with the vastness of our visible universe will be enhanced.

(7) The most exciting thing I have experienced with my big Dob was the most boring visual object you could imagine. After hours of research, using Digital Sky Survey images and planetarium software, I was able to capture in my tracking eyepiece what looked like just another 14th magnitude star among many others in its field. This particular "star" is a quasar, or quasi-stellar object, some five billion 3D light years away.[18,19]

When I gazed in awe for some minutes at this dim quasar I was looking back in light-years time at a photon source a half-billion years older than our solar system. Its few photons that directly hit my eye were sent on their way long before the Sun and Earth condensed from our ancient dust cloud nursery. That's exciting 3D astronomy of the mind.

[18] http://astronomy-links.net/InsideBlackHoles.html

[19] http://astronomy-links.net/Einstein.html