Fulcrum

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the current value of ancient astronomy.

b.cache

It's not a straightforward thing for a layman to speak of astronomy, especially in the presence of an interlocutor like Niel Turok. The task is perhaps made easier by the thought that Prof. Turok may well find himself in an equally difficult position —of finding means to explain current concepts in astrophysics to an audience of architects, without completely watering down the field's infamously complex theories.

Such is the status of science today that its advances are increasingly incomprehensible to the common man. So where exactly will today's "common knowledge" come from? And how can science still participate in the construction of an image of the communal world?

Although several worthy representatives of our species have walked on the moon, in fact we can be certain that the common man of today knows less about astronomy than any sailor from previous centuries. He is also less aware of the sky than even the ancient Greek peasants, who followed popular astronomical calendars (so-called parapegmes) and watched for the heliacal rise of this or that star before commencing their seasonal labours. This attentiveness to the celestial condition is evidenced by one of the oldest written texts in Greek, from around 730BC, called The Works and Days by Hesiod (a contemporary of Homer).

By contrast, the proliferation of GPS will soon cause road maps to disappear altogether from our cars' glove boxes. And with them will go the last of our elementary knowledge of terrestrial geography. What will be lost is the most basic capacity to orient oneself and read a map, in short, to understand our immediate surroundings through the representation of a given area. It is not without a certain irony that this disappearance is caused by systems reliant on terrific feats of astronomical calculation: the stabilisation of geostationary satellites in orbit. What, then, remains of our shared scientific knowledge, at a time when sophisticated technology increasingly shapes our lives?

This anxiety is a very old one, present at least as far back as antiquity. Plato was concerned about the consequences of the dissemination of writing technologies, having seen that knowledge no longer entailed either memorisation, or the capacity to recite at will. But above all, Plato was worried that writing would solidify texts, freezing them once and forever, such that one could not improvise or reinterpret their form as circumstances demanded. This capacity has been recovered, in part at least, through the possibility of modifying text by electronic means, that is, a formal fluctuation of the same constituent knowledge. On this subject there is a similar precedent in ancient astronomy, namely the measure of variable time.

In antiquity, the measure of day and night always lasted 12 hours (in both summer and winter) with the result that the duration of an hour was irregular throughout the course of the year. Would we even know how to orient ourselves today with these units of variable time?

We would probably find it more confusing than the most extreme jet lag.

But the question to examine is how ancient astronomy might constitute a sort of fallback position, still relevant today (even for those of us who already find it difficult to understand trigonometric equations or integral calculus).

An experience like Foucault's pendulum beautifully establishes that it is indeed the earth that turns around the sun and not the reverse. By extension, it proves Copernicus was correct and that the heliocentric and geocentric systems are not equivalent, as theologian Andreas Osiander would have had us believe.

Nonetheless, the fact remains that in our experience we still see the sun revolve around us, and we can only represent it otherwise if we imagine ourselves out of ourselves, at a point removed from the universe where we may contemplate our solar system. œ

at the edge of tomorrow.

n.turok

Bernard Cache correctly identifies the importance of astronomy, though I need to rephrase his position in my own way. Our society is built on cosmology; it's as simple as that. In ancient Greece, the Pythagoreans tried to understand the universe through geometry and mathematics. Since then, fundamental science has played the role of underpinning every new development in society.

Newton discovered the laws of motion through thinking about the planets and solar system: his discoveries underlie every aspect of engineering, mechanical construction and bridges.

Maxwell worried about electricity, magnetism and light — of course this is the most fundamental property of the universe, as it allows electric and magnetic fields and light to travel through space. Maxwell's discoveries laid the basis for all of modern communications: radio, television, etc.

Einstein, by thinking about the laws governing the universe, discovered relativity, and his theory of gravity: these theories permit GPS, space exploration, and so on.

Cutting edge technologies are based upon discoveries made by people thinking about the universe. So I would say cosmology is absolutely fundamental to our society. The discoveries of today will be the technology of tomorrow.

These discoveries might regard the vacuum energy in the universe, for example, or dark matter, or the way we've been able to map and discover the structure of the universe on the largest visible scale. We can never predict exactly how they will be used, but based on all of human history, we can be sure they will be, and whatever they are used for, it will completely change our society.

There is always debate in research, and when you're on the cutting edge it is never clear at the time exactly which is the right theory.

Therefore, consensus is not a property of cutting edge research. Consensus takes many years or maybe even decades to find.

Today [July 4th] the Higgs particle was discovered. This was proposed fifty years ago and pertains to the structure of the vacuum. It tells us very profound things about the way the world works. But at the time Higgs made his proposal, it was not a popular idea. Higgs was one of very few people working on these ideas in the 1960s. Similarly, today we have leading thinkers at the Perimeter Institute who are exploring new fundamental approaches to describing the universe. We cannot say exactly which one is the right one, but we will find out in the coming decades.

The Perimeter Institute itself is located in a small town in Ontario called Waterloo. Here, we are bringing together the finest physicists into a single complex. These are Nobel prize winners and leading thinkers from around the world. In fact, what brings them here is mainly the facility, that is, the building. The remit we gave the designers — People Architects — was to design the ultimate facility for the human mind to conceive of the universe. This task is essentially that of employing architecture to further the investigation of science and cosmology.

We told them that we needed a lot of interaction. This is because we don't want researchers stuck away in isolated corridors. But especially we need accidental interaction in our architecture, because its results are often very stimulating for scientists.

For that reason the building, and the institute, are unique in the world. And I think everybody that comes to Perimeter is kind of blown away when they see it. The goal of our institute is to make scientific breakthroughs, so we have extremely ambitious aspirations, and the fact that the facility is so unusual and has been designed around our goals is extremely impressive to scientists and researchers: they realise immediately that this is a place to live up to the highest goals in physics.

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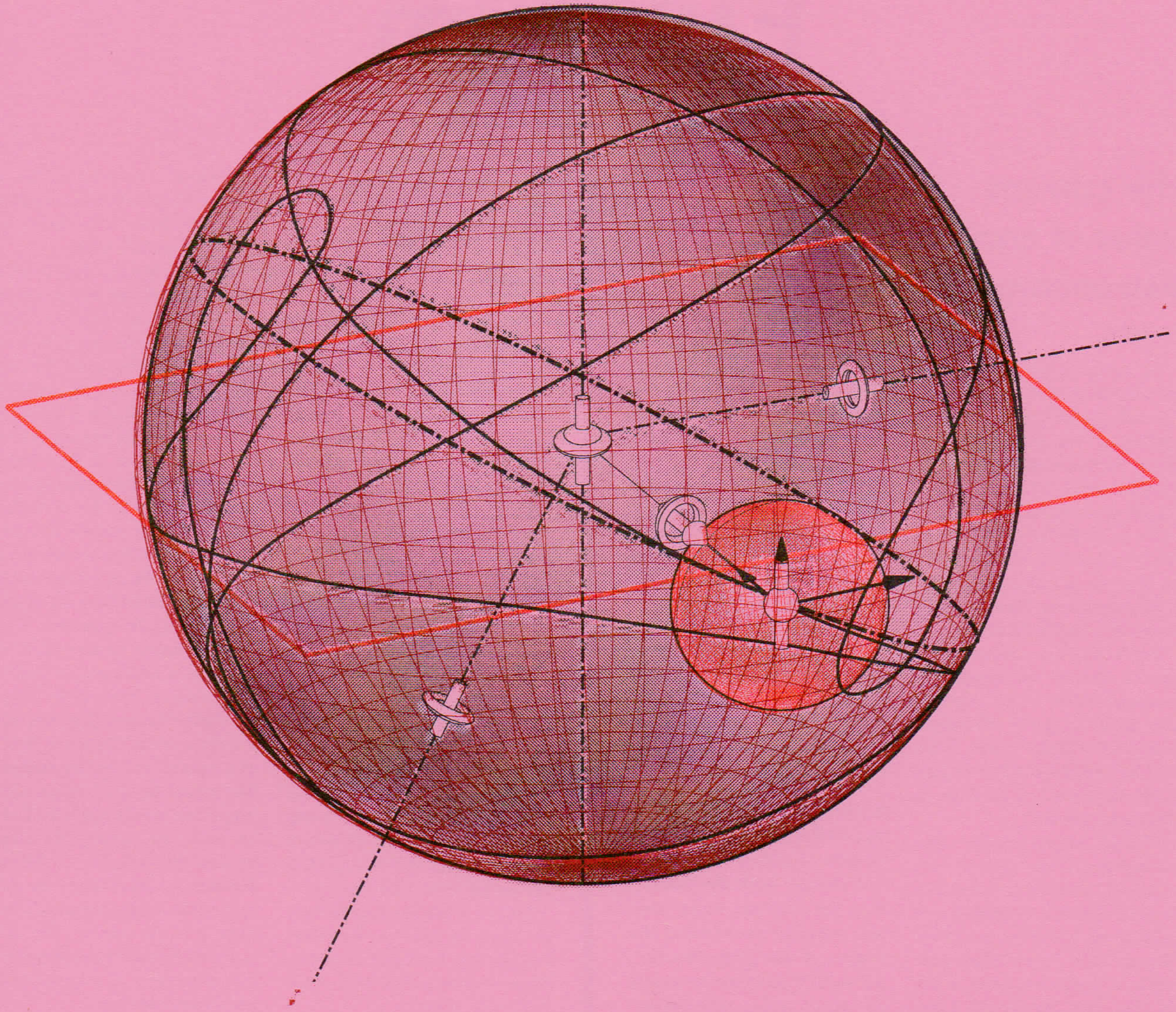

Simulation of an interlaced trajectory achieved using Eudoxus' mechanical model of homocentric spheres (~350BC). Courtesy B.Cache.

Similarly, inasmuch as we still scrutinise the sky (or visit a planetarium) we always stumble and confuse the difference between two types of celestial bodies: firstly stars (the sun and moon, which turn always in the same direction); and secondly, the planets (that sometimes stop, turn back, then resume their usual course). It is for this precise reason that they're called planets, from the Greek verb : to deviate from a straight path, to wander, or roam. It goes to show, the rudiments of Greek can still tell us something about the world.

In its day, Greek astronomy was a rather daring enterprise, namely because it founded its understanding of the movements of all celestial bodies, including those wandering stars called planets, on a composition of uniform circular motions. It's frankly amazing what these Greek scholars achieved by this method, and so early in history. Around 350BC Eudoxus of Knidos (present-day Turkey) imagined a whole system of nested spheres rotating within each other. When there are only two of these spheres we obtain a trajectory resembling a figure eight, a curve called a "hippopede" (probably because of its similarity to the prescribed path of a horse riding exercise). It is this curve that permits for an orbiting object to appear to turn back on itself, then resume its forward course indefinitely. It would then suffice to package these first two spheres within others to reconstruct the movement of planets, with their stations and retrogradations. In the nineteenth century the Italian scientist Schiaparelli demonstrated that such a model, known as the "homocentric spheres", is able to actually simulate the motion of certain planets fairly accurately, although some remain recalcitrant.

Even more surprising, therefore, was this: how was Eudoxus of Knidos able to conceive of these complex trajectories starting only with a figure eight curved in space? Here we are inclined to think he had to have made, if only in a rudimentary way, a mechanical model. This is an idea suggested by Plato in the Timaeus, who says that it is impossible to imagine the dance of planets if we do not have before us a mechanical instrument. In fact, Plato probably wrote the Timaeus (~365BC) a decade or more before Eudoxus conceived of his model. Such is the evidence that the Greeks invented mechanics in order to think about astronomy. So equally comes the suggestion that we might teach mechanics and computer-aided design today by beginning with these basic models. By this we would gain a better knowledge of both the sky and our history.

Let's jump forward in time, to 100BC, where the architect Andronikos of Kyrros was building his Tower of Winds in Athens. This building takes the form of an octagonal tower, each wall possessing a sundial. At the rear, a cylindrical tank feeds a mechanical clock, rotating a disk. This disc is a stereographic projection of the circles of the celestial sphere, and runs behind a grating that converts the regular rotary motion into units of time (which vary with the seasons). We perceive it as a building with eight sun clocks designed primarily to house a complex mechanical device.

Were we to name it in Latin it would be called aedificatio, gnomonica, machinatio: the three components given in Vitruvius' second definition of the discipline of architecture. Better yet, the first building that we see mentioned in his De Architectura is not a temple, but in fact Andronikos' Tower of Winds. Here it is that the inaugural treatise of our discipline gives priority, not to a theory of architectural orders, but to parametric devices designed to reflect astronomical phenomena…

Bernard Cache is an architect and philosopher. His work, and that of his firm Objectile, has been central in defining "non-standard" architecture. Translation by Jack Self.