The Universe in a Single Atom: Communicating Astronomy through Metaphor

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Imagination is more important than knowledge. Albert Einstein

Effective science communication requires a return to the mind of a beginner. This is a critical detail to remember because astronomy is, above all else, a remarkably complex subject. Since astronomy is initially a study of the abstract, observations of mysterious targets in the archives of time, we slowly forget our initial self. Novelty gives way to expertise. The problem is that effective astronomy communication requires a kind of scientific translation, a process made possible only by understanding the novice stargazer. And one of the best ways to accomplish this goal is communicating through analogy and metaphor.

We often think of metaphor as a tool for authors and poets. This, no doubt, is true. Delivering one idea through a separate, but more tractable idea goes back at least to the days of Aristotle, who studied its importance in epic verse. The modern use of metaphor has changed little in the 2000 years since its analysis among the ancient Greeks, and this is certainly true for astronomy. The Big Bang, dark matter, black holes, shooting stars and event horizons are all — at least in some respect — conceptual metaphors designed to wrap our heads around big ideas. While it may turn out that some of these descriptions are true (e.g. dark matter really is dark), much of this metaphorical work is used to satisfy the mind's insatiable appetite for concrete images. And this is precisely how we can find the Universe in a single atom.

Consider the relationship between atoms and the cosmos. Electrons whirling around an atomic core are a lot like planetary orbits, or so we have been told. Conversely, the parabolic paths of moving bodies turn out to be a nice analogy for zipping electrons. But astronomical metaphors have not always been so vivid. Consider Johannes Kepler's "music of the spheres", an attempt to connect music with motion in the Universe. As a result of his new understanding of the cosmos, the night's starry skies were no longer conceptualised as a perfectly aligned clock. Rather, Kepler's Universe fused a series of apparently unrelated dimensions (arithmetic, geometry and music), all of which contributed to a sublime understanding of the cosmos. Yet there is a sense that Kepler is after something far deeper than is revealed from the surface. For Kepler, astronomy could be neatly captured in a quirk of language based on analogy and metaphor. Beautiful as Kepler's music may have been, such metaphors have never been confined to astronomy.

A computer program, for instance, is neatly understood through the metaphor of branches in a tree. The mind, it has long been said, is like a computer. More recently, culture has been likened to a kind of mental software. Modern bridges, equipped with fibre optic cables and sensors, are analogous to structural nervous systems. Even cities are conceptualised in terms of living organisms, complete with proportionally scaled metabolisms. Our Universe, it seems, is ruled by mechanical properties best conveyed through elegant verse. There is poetry in the stars.

Such is the case with metaphor, my standard operating tool for explaining fundamental concepts in astronomy. Take Einstein's general theory of relativity, not only one of the most popularised ideas in all of science but also one of the least understood. The general theory has a profound impact on our lives, affecting everything from global positioning systems to mobile phones. And while the general theory continues to impact every corner of the planet, its basic principles are understood by few people. This is why, during the course of explaining Einstein's general theory to a novice, metaphor remains my most reliable tool.

Consider the difference between tables and cubes. Instead of jumping into a complex 4-dimensional cube, I use an ordinary mental image of 2-dimensional flat space. This is the same planar geometry with which everyone is familiar, to which I add just a dash of complexity. Such layering requires one to imagine that the hard surface of a 2-dimensional plane is now a sheet of tensile fabric, such as a trampoline. And resting at the centre of the trampoline is a rather dense sphere which causes the spatial fabric to warp and stretch. The final phase asks one to envision the sphere spinning in place, its rapid revolutions causing the spatial fabric to warp and twist. And encompassing the entire process is a constant return to the original image, a hint of 2-dimensional space. If properly unveiled, the new example provides a vivid and practical visualisation that is rarely forgotten. The novice takes away a vivid mental model of Einstein's general theory of relativity.

But of course, this metaphor is old news. It is the same strategy used by one of astronomy's most ardent popularisers, Carl Sagan. Because of its effectiveness, it continues to be invoked by modern luminaries such as Brian Greene and Neil deGrasse Tyson. Yet it survives despite its imperfection, which is precisely the point. When lost in downtown Tokyo, the last thing one needs is a perfectly designed map. Instead, the greatest navigational aid is a simplified depiction of Tokyo illustrating only its key landmarks and structures. The same holds true for effective astronomy communication. Since graphic images are sometimes not at our disposal, as is often the case in public astronomy, the creative use of language becomes our strongest ally. And at the root of this strategy is analogy and metaphor.

All of this brings us back to the beginner's mind, which is the state of our initial understanding of a complex problem. Grasping difficult astronomical concepts requires dedication and focus, qualities that usually lead to an intensely narrow perspective. Such are the requirements for grasping basic astronomical principles. But with a little help, we can learn to recall our first glimpse into the night sky and then transfer that knowledge on to others. Fortunately, the vehicle of analogy and metaphor can help take us there.

Biography

Matthew McCool teaches writing at Southern Polytechnic SU (Atlanta Georgia, USA). He studied intercultural communication at New Mexico SU (USA), literature and philosophy at the U of Illinois at Springfield (USA), and neuroscience at the SIU School of Medicine. He is finishing a book about intercultural writing called *Writing around the World* (Continuum).