

I remember one summer's day, too long ago to place, lying in a garden and staring up at the sky. I noticed little, clear, worm-like shapes in my vision, which I later learned to be eye floaters. Changes in the jelly-like substance in the eye form short squiggles that follow your gaze wherever you look. The sensation was slightly alarming: this was something in my eye. But once they became familiar, I began to treat them like a game, trying to move my eyes fast enough to outrun them. It never worked, but it always felt like it could, if only I looked forcefully enough.

The brain does not see light. It is enclosed, operating in darkness, receiving electrical signals that correspond to what we perceive as illumination. Vision is not the direct encounter it feels like, but a reconstruction assembled from signals. A simple experiment reveals this: press your fingers into your eyes and shifting patterns and colours appear, caused by mechanical stimulation of retinal cells. This pressure tricks neurons into firing, creating kaleidoscopic imagery and bursts of light. Sight is, in itself, a kind of abstraction.

The act of observation, then, is not passive. Light must strike an object to make it visible; instruments must interact with what they measure. There is no image without a surface. Even our presence alters outcomes, however subtly, an imperceptible shift at the smallest scale.

When the Hubble Space Telescope was first launched, its images came back distorted, not because of space, but because its mirror had been polished slightly incorrectly. A deviation measuring a fraction of a human hair was enough to blur entire galaxies into smears. The instrument carried its error outward, projecting it onto everything it observed.

Even in controlled scientific conditions, contamination persists. Samples from the Ryugu asteroid, returned by the spacecraft Hayabusa2, were found to contain terrestrial microbes after arriving on Earth. Despite rigorous clean-room protocols, Earth bacteria colonised the surface of the material, forming rods and filaments that complicated analysis. These organisms blurred the boundary between the extraterrestrial and what is merely a projection of life from our own planet.

Yet the most persistent source of contamination is not external, but internal. We do not approach the world without assumptions, biases, and limitations. The limits lie not only in what we see, but in what we can conceive. The scale of the universe is often described through analogy, that there are more stars than grains of sand on Earth. The comparison gestures at magnitude, but does not feel fully graspable. One incomprehensible thing is exchanged for another.

Mathematics, often treated as a universal language, operates in much the same way. It is a system we invented to describe reality, yet it produces ideas that exceed our ability to imagine them. What is the largest number we can meaningfully hold in our minds? At a certain point, magnitude ceases to be experienced and becomes only symbolic.

There are numbers that resist compression into concise notation, whose only possible description would be the exhaustive listing of their digits, a task so vast it could never be completed. These numbers are not extraordinary because they are the *largest* numbers, but because they fall between the rare milestone numbers that we are able to name, such as a googolplex, Graham's number, or TREE(3). Between these landmarks, there is an expanse we simply cannot see. In this way, mathematics reveals the power of human abstraction, but also its limits.

And so what we call understanding is never simply receiving what is there. It is an encounter limited by our bodies, instruments, and ideas. To look at the night sky is to look across immense spans of time, to witness light that has travelled for thousands, sometimes billions, of years. Yet at the moment of contact, something intervenes. There is always a surface, a medium, a layer.

Steve Bishop, April 2026