Worlds In a Beam of Light

By Greta West

I have a picture on my desktop downloaded from NASA's Hubble Telescope website at http://hubblesite.org/gallery/album/galaxy/pr2007041a/large_web/. It's an image of a spiral galaxy with the distinctly unromantic name of M-74. Back in the eighteenth century a French guy named Charles Messier catalogued all the so-called "nebulae" he could see and gave them numbers. He did so for a very practical reason. These vague smudges of light were often mistaken for comets, and in those day a good way for astronomers to make a name for themselves was to discover a comet. You discover it, you name it — usually after yourself. Nebulae were essentially sky pests to be identified and filed away. Nobody knew what they were, and comets were much more interesting.

The word "nebula" (plural, nebulae) derives from a Latin word meaning "mist." The telescopes of Messier's time could not distinguish one patch of sky-mist from another, and so Messier never knew that nebula M-74 was actually an entire system of stars separate from our own. Other of the nebulae he catalogued were actually clouds of dust and gas contained within our own galaxy. These days we make a distinction between true nebulae, and galaxies like M-74.

The Hubble telescope shows us M-74 face on, a frosty whirlpool of stars turning against cosmic blackness. You will notice pink smudges scattered throughout the spiral arms. These are true nebulae similar to M-16 (the Eagle Nebula) in our galaxy. (See the image at http://www.dsi-astronomie.de/M16.html). They are composed of hydrogen and other elements that glow due to newborn stars within catching their first fire. The entire galaxy is traced through with winding labyrinths of dust and gas that partially block starlight. M-74 is literally clogged with dust, as is our Milkyway. The outer reaches of the spiral appear deceptively cold, like frost on a wintry pane of glass. However, they're actually composed mainly of young, hot stars much larger and brighter than our sun. Closer to the center of the galaxy the colors turn warmer, yet these regions are actually made up of older, cooler stars, red and yellow dwarfs not unlike our sun. The hub of the galaxy glows a pinkish-white hue like a candle seen through a bank of fog. There is probably a monster black hole lurking there, though we see so sign of it.

M-74 is so beautiful it almost takes the breath away, and knowing a little about what one is seeing only deepens the beauty. I feel the urge to own it somehow, to hold it in my hands like a delicate seashell found on a beach. Like clouds that form themselves and go, galaxies too are temporary formations, but on scales of time and space so vast the imagination founders. Our own galaxy takes about a quarter of a million years to make a complete rotation around its center. In that interval, patterns of stars, nebulae and dust-lanes have shifted, melted, and re-formed. In the time the Earth has existed the patterns of stars in our sky have rearranged themselves again and again. A million years ago an astrologer would have had an alien collection of constellations to ponder and plot. I wonder what destinies she would have augured?

Charles Messier can be forgiven for thinking M-74 was a patch of mist, for even Hubble sees it as a luminous cloud. Yet that cloud is composed of individual suns, and the distance between any two stars is so great it challenges our ability to imagine it. The closest star to our sun is Alpha Centauri. For comparison, it takes a radio signal about a second and a half to reach the moon, and several minutes to reach Mars. A radio signal, traveling at the speed of light, would take over four years to reach Alpha Centauri. This is about average as star distances go. This means that for all its dazzling structure and beauty, M-74 is mostly empty space.

Now consider this. The fastest probe ever launched from Earth is Voyager 2. As of May 2008 its speed was about 17.1 kilometers per second, or 38,400 miles per hour. At that tremendous speed it will take Voyager about 73,000 years to reach the distance of our nearest stellar neighbor, or more than seven times the span of human history. To make matters worse for poor Voyager, it isn't even headed in that direction. It is doomed to wander the interstellar wastes forever.

Even so, measurements like these only scratch the surface. When you behold the sky on a cold winter's night far from the light's of the city, stars seem so thick and deep you fear you might might lose you grip on the planet and tumble into vastness. Yet in spite of the awe you might feel, you are seeing only the surface of things, the thinnest outer layer of the cosmic onion. On such a night, with good eyesight and patience, you might count about 4,000 stars. Yet our single galaxy is composed of billions— a number so big it has no real meaning. To deepen the mystery even further, even astronomers can see only a fraction of what's really there. In recent decades they have come to realize that visible matter makes up only about ten percent of the universe. It comes as a shock to realize that ninety percent of the universe is hidden, undetectable by our instruments. Dark Matter, they call it . . . and they don't even know what it is.

Researchers "discovered" dark matter by watching the way distant galaxies like M-74 rotate. Galaxies, like solar systems, are gravitationally bound. All those multitudes of stars rotate about the galactic hub the same way Earth rotates around the sun, and the moon around the Earth. Smaller things like the Earth and moon (and NASA probes) obey the tried-and-true laws of gravity in a very predictable way. If M-74 obeyed those laws, its most distant stars should lag behind stars nearer to the hub. They do a little, but not enough. The entire galaxy appears to rotate almost as a unit, like a vinyl record on a turntable. It's almost as if M-74 were embedded in a much larger gravitation pool. Something that massive should be detectable somehow, in some wavelength of radiation, but it's not.

20th century biologist J. B. S. Haldane once quipped that the universe is not only stranger than we imagine, it is stranger than we can imagine. He had no idea how right he was, for it now appears that the visible universe is merely the spume atop a wave within an unseen cosmic ocean. Physicist would really like to know what that ocean is made of.

Our telescopes have detected a loose structure to the universe. Galaxies appear to clump together, and those clusters form larger super-clusters. All this clumping has left vast spaces in between where no stars or galaxies reside — intergalactic deserts, or voids. If we could see it all with the unaided eye the universe might look like a three dimensional lacework that has been tattered and scattered by a fierce

wind. Voids often appear as bubbles of emptiness not unlike those that form in a sink full of soapy water. The suds are made up of intersecting bubbles both large and small. Now imagine clusters of galaxies the size of dust motes gliding across the surface of those bubbles. The universe is foamy.

The force of gravity dominates the universe. Just as the Earth remains in orbit about the sun due to gravitation, gravity also influences the structure of galaxies and galactic clusters. Though the universe as a whole expands in all directions, gravitation can overcome that expansion and pull entire galaxies into collision. We have snapped pictures of those galactic train-wrecks in progress, a process that takes millions of years to complete. Remarkably, since galaxies are mostly empty space, one can pass through another without any of the component stars colliding. This does not mean, however, that the victims escape unscathed. We see galaxies left in tattered ruins after such interactions due to the effects of gravitation. Tidal forces pull streamers of stars across many millions of light-years, often flinging individual stars into the intergalactic void. One shudders to think what the sky looks like from the planet of such an exiled sun. One side of the sky blazes with streamers of starlight, but on the other there is nothing but eternal blackness.

The lovely M-74 has escaped such havoc thus far, which accounts for its crystalline structure. At thirty million light-years, M-74 is practically our next-door neighbor. Our telescopes can peer much farther than that, however, and when they do they are actually looking billions of years into the past. Charles Messier never realized that his telescope was also a time machine. At the limits of visibility we can see nascent galaxies exploding with the power of billions of stars. We are lucky to live when and where we do, for the infant cosmos was a violent time and place. At such extreme distances it is difficult to understand what is happening, and so researchers are left guessing and excited to live in a moment in history when they are privileged to do so. They hunger to know more.

This sort of thing often makes people feel small and insignificant —which is not, as I argue below, always a bad thing. A deeper understanding of reality is often a humbling experience, yet when I look at Hubble's image of M-74 I feel something else besides, something I can't quite put into words. It is a feeling of awe, yes, and wonder too; but it is more than that. I am struck by the fact that something so remote and vast can also seem so beautiful and so compelling, as if I own it in some sense. For the universe that made M-74 also made me. I am a part of that spectacular loveliness. As I gaze out through my powerful new eyes I am also gazing inward. I see myself — not my hum-drum self of wilting flesh, of taxes and politics, love gained and lost, of nightmares and shattered dreams — but at a self I dare to call spiritual. Though science itself is not worthy of worship, it is, I say, a way of participating in the deepest of all mysteries — the unfathomable mystery of being.

As our galaxy wheels through unfathomable stretches of cosmic time, its stars flow and shift so slowly that we are unable perceive the changes in a human lifetime, nor even in several. It takes thousands of years to notice the difference, and indeed the constellations we see today are a little altered from the ones the ancient Babylonians employed to fashion astrology. If this is so one might as well seek one's destiny in the rust stains on the flank of a water tower, for the constellations in our sky are truly random patterns, a snapshot in galactic time. But perhaps the conceit that the stars revolves around us was due to a deeper intuition that we human beings really are a part of that vastness. Carl Sagan used to say that

we are literally made of stardust. The elements that compose our bodies were forged deep in the hearts of supernovae, exploding stars, billions of years ago. The same is true of sunflowers and seashells, of everything we see and much we don't. The cosmos produced me. The writer Alan Watts put it this way. "As the ocean waves, the universe peoples." In other words, I am not an object that happens to exist; rather, I am something the universe does. I am a verb, not a noun.

I freely admit I don't feel very cosmic given the state of the economy and my own personal fiscal concerns. In fact I often feel downright frightened. But this is exactly what's so subversive about human life. It forces to focus so much on trivialities that we lose sight of what is real. Hubble is there to remind us what is real. It is our eyes on reality. It has never made sense to me that so many people think science works to strip our lives of mystery and wonder. It doesn't, and it can't. Every time someone discovers a new way to look more closely at the universe, a new way to broaden our understanding, the mystery only deepens. And the deeper we look, the more mind-boggling it becomes. Edwin Hubble, after whom our space telescope is named, could see only faint smudges of light through his telescope at Mount Wilson. His careful observations showed that the universe extended beyond our galaxy, that those smudges were indeed other "island universes." He also showed that the universe-at-large was expanding, literally flying apart. Now, however, with the news that the visible universe is only a small fraction of the whole, I imagine Hubble spinning in his grave with disbelief.

But I also imagine how Edwin Hubble's heart would have ached to behold what I see on my humble desktop. My image of M-74 is so detailed he would scarcely have believed it. As the Hubble telescope opens our eyes, it also opens our hearts and expands our minds. Science is not a tool for stripping away awe and beauty, but a means of enhancing it. The father we are able to see, the more we realize there is to see. Every time we strip away a layer of the cosmic onion we find yet a deeper layer, and the onion seems to go on forever, with no center, no end, and no beginning.

Albert Einstein once said that the most incomprehensible thing about the world is that it is comprehensible. Indeed, I often hear people say as much. They can't possibly know that stuff, they say. Such skepticism about the efficacy of science expresses an implicit rejection of the way nature is put together. Indeed, if you believe God made all this, it constitutes a rejection of God.

Consider, for example, an ordinary beam of light. Light contains worlds of information once you know how to analyze it. By observing the light of distant galaxies Edwin Hubble was able to conclude that they were moving away from us. He did this by examining the light of distant galaxies, measuring what's called the "red shift." The red shift is a result of the doppler effect. We experience the doppler shift when we hear the siren of an approaching ambulance. The pitch of the siren seems higher as it draws near, then falls in pitch as it races past us. Likewise, light, too, changes pitch as the source moves away or draws nigh. When a distant light source moves toward us, the color is bluer; moving away it looks redder.

Light can also tell us what distant things are made of. If you pass the light of the sun through a prism you see a rainbow of colors — its spectrum. If you analyze that spectrum carefully you'll notice something strange. The colors are interrupted by light and dark lines and look something like the bar code on a box

of cereal. These lines are called emission and absorption lines, and depending were they lie in the spectrum they will tell us what the sun is made of. They are the fingerprints of the elements. This is how helium was discovered in 1869 by Pierre Janssen and Norman Lockyer. Lockyer named helium after the Greek sun god Helios.

Such knowablity is mind-boggling thing when you think about it. As Einstein observed, it is almost unbelievable that distant phenomenon are so knowable, once you know how to look. If one believes in God, one is forced to conclude that God wanted us to figure these things out, for He, She, or It embedded the keys to the universe within ordinary light. When Galileo first turned his crude telescope to the heavens and saw craters on the moon and the moons of Jupiter, his contemporaries found it unbelievable. They suspected it was some kind trick, or an illusion. Worse yet, it could have been the work of the devil.

Needless to say, the devil is still at work today. Modern creationists are still denying the fantastic potency of science. To paraphrase Einstein, they still find it incomprehensible that the world is comprehensible. Such rejection is understandable I suppose. Many people seem to feel intimidated by the sheer scope of the universe revealed through the lenses of the Hubble telescope. It makes them feel small and insignificant, a mere mote amid immensity. They fear it makes their lives meaningless. Back in the 19th century when geologists were starting to realize how old the Earth was, certain thinkers were upset about that as well. Why, they asked, would God allow all those millions of years to pass with no human being to worship Him? This sense of meaninglessness is expressed poignantly in this poem by Alfred Lord Tennyson:

There rolls the deep where grew the tree.

O earth, what changes hast thou seen!

There where the long street roars hath been

The stillness of the central sea.

The hills are shadows, and they flow

From form to form, and nothing stands;

They melt like mist, the solid lands.

Like clouds they shape themselves and go.

Likewise in this passage by Matthew Arnold:

What is the course of life

Of mortal men on the earth?—

Most men eddy about

Here and there—eat and drink,

Chatter and love and hate,

Gather and squander, are raised

Aloft, are hurled in the dust,

Striving blindly, achieving

Nothing; and then they die—

Perish;—and no one asks

Who or what they have been,

More than he asks what waves,

In the midmost Ocean, have swelled,

Foamed for a moment, and gone.

These nineteenth century poets were filled with existential angst even while lacking knowledge of the true extent of the universe. These days it seems that even entire galaxies are merely waves in midmost ocean that swell, foam for a moment, and pass away. Against this backdrop one might feel justified in asking what meaning or purpose there can be to mere human life? Such lamentations are nothing new of course; the philosopher of Ecclesiastes was posing the same questions a thousand years before Christ:

Vanity of vanities, says the Preacher,

vanity of vanities! All is vanity.

What does man gain by all the toil

at which he toils under the sun?

A generation goes, and a generation comes,

but the earth remains for ever.

The sun rises and the sun goes down,

and hastens to the place where it rises.

The wind blows to the south,

and goes round to the north;

round and round goes the wind,

and on its circuits the wind returns.

All streams run to the sea,

but the sea is not full;

to the place where the streams flow,

there they flow again.

So it would appear that this sort of questioning, this yearning for meaning, is a fundamental part of what makes us human. No other species on Earth, as far as we know, questions the meaning of its own existence. It requires no great leap of the imagination to guess the reason why: It is because we human beings are able to imagine, and to reason; it is because we are self-aware. Due to our oversized cerebral cortex we are able to ask why the sun rises, and why the rain falls. We remember the past and imagine the future, and so we seek our destinies in random patterns of stars. If we are able to ask, Where did I come from? we can also ask, Where did the world come from? and so we imagine ourselves a part of a purposeful Creation, and a part of the Creator's great purpose.

We are indeed an interesting species, as was stated in Carl Sagan's novel Contact. "You are capable of such wonderful dreams," said the paternal alien, "and such terrible nightmares." Those dreams and nightmares run the gamut from visions of Eden to vengeful gods who eternally torment the wicked. We are haunted by demons even while the angels watch over us.

If we see our destinies written in the stars it is because the heavens serve as an ink-blot test. And beyond the visible stars, the universe at large serves the same purpose; it is the greatest Rorschach test there ever was or ever could be. It is no surprise, then, that we populate the cosmos with demons and angels, that we read our dreams and nightmares into that starry ink-blot. One prominent 20th century astronomer declared that the more we know about the universe, the more it seems utterly meaningless. Now compare that to this thought from physicist Freeman Dyson from his book Disturbing the Universe:

It is true that we emerged in the universe by chance, but the idea of chance is itself only a cover for our ignorance. I do not feel like an alien in this universe. The more I examine the universe and study the details of its architecture, the more evidence I find that the universe in some sense must have known that we were coming.

Since Dyson wrote those words in 1979 it seems we have seen a backlash against the fashionable existential pessimism of previous eras. It is almost as if we, as a society, were stunned by having our cozy little human-centered universe stolen from us; a cosmos of which we were the center. Dyson, according to his writings, is not religious in any traditional sense; yet his reaction to the cosmos is "religious" in a broader sense. The quote above expresses his astonishment that the fundamentals of reality are such that life and self-awareness are not only possible, but inevitable. After all, the universe could have been a very different place had the values of the fundamental forces been only minutely different. The universe seems "fine tuned" to allow us to exist.

Personally, I don't know if the universe "knew" we were coming. The argument can be made that if the fundamental forces of nature had been different we wouldn't be here to discuss it; therefore, the fact that we are here means that the universe had to be the way it is. (That reasoning goes 'round and 'round in circles.) It does seem to me, though, that we do, in some sense, "conspire" with the universe. The word conspire derives from Latin roots that means "to breathe with." Likewise, inspire means "to breathe in"; expire, "to breath out". Ultimately, the word "spirit" comes from the Latin for "breath" from spirare, "to breathe." As we live and breathe, we are literally spiritual beings. We conspire with the cosmos, and are inspired by it. It breathes life into us, for life is an inevitable product of the way the universe is made. As the ocean waves, the universe peoples.

Like Timothy Ferris in The Mind's Sky, I do not share the sentiment that the enormity of the cosmos should make us feel insignificant. Ferris goes on to say why:

The stars are too involving for that; they stimulate our curiosity, arouse us to reflection, nourish our sense of beauty, and challenge our conception of who we are. We feel connected to them, somehow. I do not think this intuition can be dismissed as mere sentiment, for the simple reason that we are able to some degree to understand what goes on out there.

It is impossible for me to see the universe (as revealed by science) as a scary place. To the contrary, the sight of all those wheeling galaxies inspires me. I breathe in. My breath catches in my throat. Though I see no sign of angels and demons roaming the spiral arms of M-74, I do not feel, as Dyson said, like an alien in the universe. It is much too involving.

And yet there are those, even in intellectual circles, who seem to view the scientific enterprise as somehow demeaning or dehumanizing. They criticize something they call "scientism." According to one definition I came across in The Nation magazine, scientism is the attitude that the only valid means of understanding is a scientific one. It must be said, however, that the only people who use this term are those who are against it. Those who actually practice scientism see no meaning in the term, for what is the alternative but ignorance? Would we be better off or become more spiritual if we smashed our telescopes and ground our collection of fossils to dust and ignored our evolutionary past? Of course not. Scientists, after all, are human beings too, people who suffer broken hearts, read poetry, and agonize over moral quandaries the same as poets and literary critics. Though Love can be subjected to scientific scrutiny, science cannot diminish the power and value of Love as long as we remain human. The myth of Mr. Spock, the unemotional and purely logical man, is just that — a myth.

It seems to me that those who ignore the empirical revelations of science deprive themselves of an endless source of inspiration, and therefore of a certain spirituality. All education, whether in the humanities or the sciences, is an invasion of personal privacy. It challenges us to look at the world in new ways, and to search within ourselves. Why would we bother to gaze at the Milkyway scattered across the night sky, but refuse to peer through a telescope? Telescopes educate us. They expand our horizons. If the view frightens us, it is only because we are also gazing back at ourselves.

The same anxieties also haunt those in not-so-intellectual circles. Modern creationists, for example, are still insisting that the Earth (and indeed the entire universe) is no more than ten thousand years old. But if this is so, the astronomer retorts, how is it that we can see galaxies that are millions of light-years away? After all, if the universe is so young, the light of distant galaxies would not have had time to reach us! The creationist's answer is simple: God created the universe with the light of distant objects already on its way. In other words, creationists were willing to believe in a trickster god — a god who would lie to us — in order to cling to their literal interpretations of Genesis. This kind of thinking shows that even for religion, the consequences of denial are grave indeed.

Alan Watts points out that faith is (or can be) a cover-up for doubt and uncertainty. Watts went on to say, "Irrevocable commitment to any religion is not only intellectual suicide; it is positive unfaith because it closes the mind to any new vision of the world. Faith is, above all, open-ness — an act of trust in the unknown."

If faith is trust in the unknown, then there is plenty of faith to be found through the lenses of a telescope. For even as our scientific instruments inform us, they also reveal the extent of our ignorance. I often hear people deny the efficacy of science by insisting that "scientists don't know everything"; yet no one is more aware of this fact than scientists. As they peer deeper, and deeper yet, the unknowns keep piling up. Ironically, the more we know, the more we realize there is to know. Therefore, our investigations into the workings of the world have left us plenty of faith to go around.

If Alan Watts is correct, then, it seems strange that creationists and certain intellectuals have so little trust — or faith — in those unknowns. It seems they had rather cling to the more comfortable unknowns of the past, before Copernicus displaced the Earth from the center of the universe. The trauma of that displacement is still being felt today, by millions. She who seeks her destiny in the stars implicitly subscribes to an obsolete cosmology — that of the ancient Babylonians in which Earth sat at the center of a sphere of familiar constellations. Likewise for creationists who demean their own god with their attempts to reduce the cosmos to more comfortable dimensions. If Watts is right — if faith is an act of trust in the unknown — then an agnostic astronomer or an atheist biologist practices far more faith than any Biblical literalist. When we deny the immensity of the cosmos, or that we human beings are genetically related to all life on Earth, or when we deny that our bodies are composed of stardust — we reject the stunning wonder of reality, and in doing so we reject whatever god made this reality. The revelations of science force us to redefine ourselves. We ignore them at our spiritual peril.

As Darwin said in The Origin of Species, there is grandeur in this view of life. If that grandeur makes us feel diminished, then perhaps we were due for diminishment. Lord knows, the arrogant faiths of the

past have bequeathed us no end of mass graves dug in the name of God. The commandment of Genesis to subdue the Earth has left our planet teetering on the brink of a mass extinction that rivals that of the Pleistocene Era. If we realize what small and arrogant creatures we are, perhaps we would be humbled into taking better care of ourselves and the beasts with which we share our planet. If we ruin it, there is nowhere else to go. The Earth circles the sun in its endless rounds, a little blue dot amid a wasteland of cold and lifeless sister planets. Beyond Neptune and Pluto, and beyond the Kuiper Belt, stretches an airless desert of such magnitude that it cannot be imagined. Beyond that desert our telescopes have spotted other planets circling other suns, but they appear to be hellish places. If there are other Earths out there harboring alien ecologies we have yet to find them; and even if they do exist it would take many human lifetimes to reach them. Even Methuselah wouldn't have survived the voyage.

It is an odd and desperately ironic thing, when you think about it, that so many of us have claimed to be humbled by the glory and majesty of God, while rarely in our history have we behaved humbly. Why is it that faith in God has so often led believers not to brotherly love, but to cruel inquisitions and holy war? Why is it that the history of Europe is bathed in blood over the issue of who is Catholic and who is Protestant? Likewise, the word Islam literally translates as "submission" (submission to God, presumably) yet those who most adamantly "submitted" went on to conquer half the civilized world by means of the sword. It should be apparent by now that when we imagine ourselves in possession of The Truth, we behave badly. Not everyone, of course, but collectively the True Word of God seems to drive us toward madness.

Now step back and comprehend the world as it really is, a tiny speck of dust warmed by a small spark of nuclear light lost amid a myriad of other points of light, all a part of the whirlpool that constitutes our Milkyway galaxy. Imagine observing it from the galaxy M-74 thirty million light-years away. Seen from such a distance the spiral arms of our galaxy appear as mere wisps of neon fog. Individual suns, both great or small, cannot be distinguished, much less our little planet. From such a distance the stage upon which we play out all our religious and political passions is utterly invisible. Perhaps this is how God, if one exists, wants us to see ourselves.

If all this is a deliberate creation, and if that creator fashioned the laws of physics such that we are able, to some degree, to understand what goes on out there, then it becomes obvious that the creator wished us to see ourselves as we truly are. If this is so, then perhaps the creator intended us to feel a little scared and a little lonely, and truly humbled. Maybe those emotions are there in order to force us into communion with our fellow creatures, both human and otherwise. Furthermore, it doesn't matter how flawed our scientific understanding of the world is, for even a partial understanding is humbling enough. It opens our eyes to how little we know. And if there is no such thing as a scientific absolute truth, then how elusive is a transcendent one?

I would not presume to know the mind of God. But when I strain my imagination and try to see myself and my planet from a godlike perspective, I imagine my species clinging to its little mote of dust like castaways on the shores of a cosmic ocean, most of which lies unknown. I imagine God nodding in approval at the fear and awe I feel as I test the tools He left lying on the beach, tools with which I

perceive my predicament. Given what small and fragile creatures we obviously are, one cannot but feel both humbled and inspired.

“For small creatures such as we, the only thing that makes the vastness bearable is Love.”

—from the novel Contact by Carl Sagan.

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