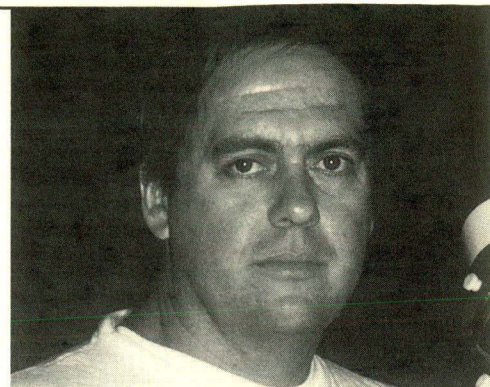

The Unlimited Cosmos— A Personal Odyssey

Alan Hale



*When I heard the learn'd astronomer;
When the proofs, the figures, were ranged in columns before me;
When I was shown the charts and the diagrams, to add, divide,
and measure them;
When I, sitting, heard the astronomer, where he lectured with
much applause in the lecture-room,
How soon, unaccountable, I became tired and sick;
Till rising and gliding out, I wander'd off by myself,
In the mystical moist night-air, and from time to time,
Look'd up in perfect silence at the stars.*

—Walt Whitman, from *Leaves of Grass* (1865)

With a Ph.D. in astronomy, I suppose I can be considered a “learn’d astronomer,” and indeed I spend a lot of my time in front of a computer terminal, poring over “the charts and the diagrams, to add, divide, and measure them.” But I am not one to forget what drew me to the field in the first place; from my youngest days I have spent innumerable hours looking up “in perfect silence at the stars,” and I continue to do so to this day. In my view, these two approaches to astronomy—indeed, to all sciences—are complementary; while I will always enjoy the spectacle of a star-studded night for its own sake, it is the hours, years, and decades that I and other astronomers have spent unraveling the secrets of the cosmos that give true meaning to that spectacle.

It was natural, if perhaps slightly egotistical, for the earliest human beings to believe that the universe consisted of their own immediate surroundings, and that the various happenings in nature occurred at the whims of various supernatural entities; elaborate belief systems were constructed for the purpose of trying to convince these entities to produce one series of actions in lieu of others. Each scientific discovery, beginning with the fact that another tribe of humans lived on the other side of the mountains, has tended to remove this egocentrism from our collective belief. As Carl Sagan so eloquently stated in his book *Pale Blue Dot* (Random House, 1994), “modern science has been a voyage into the unknown, with a lesson in humility waiting at every stop.” While we’ve been engaged in removing ourselves from

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the center of the universe, we’ve also studied the processes of nature; and, while we’re a long way from understanding everything that goes on around us, we’ve learned that there is no need to invoke supernatural forces as an explanation for the phenomena we see.

Although all the sciences have played a major role in this decentralization, it is perhaps astronomy more any other that has brought this “lesson in humility” down upon us. During the past two thousand years we’ve progressed from the idea that the Earth—as it was known at the time—was the center of all creation, to the realization that the Earth is only one of a set of nine planets, together with several smaller objects, orbiting a rather

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obscure star that is only one of several hundred billion similar stars contained within the Milky Way galaxy, itself only one of several hundred billion other galaxies scattered throughout the universe. With this view, the idea that we on the Earth hold some type of privileged position within the universe, or that one particular group of individuals on this planet holds a supernaturally ordained privileged position over its other inhabitants, is recognized for the absurdity that it must be. However much we may not like it, our Earth, and we, its inhabitants, are trivially insignificant compared to the universe as a whole, and thus our personal interactions, our collective morality and, by consequence, our progress beyond where we are today, can only be derived from our own collective conscience. This view of the cosmos tells us that there is no universe-spanning entity that is going to take the trouble to visit this tiny remote dot in space and tell us how to live; we have to figure that out for ourselves.

Along these lines, then, I’d like to look at three recent astronomical discoveries that can and should play a significant role in how we view ourselves within the cosmos as a whole. The first two are major discoveries in their own right and only serve to

increase the process of de-centralization that has been going on for the past several centuries. The third, while understandably important to me personally, cannot rank with the other two in terms of its overall importance; however, I believe it provides an important vehicle for those of us who understand our place within the cosmos to share this with our fellow human beings, and to introduce them to the wonders embodied by the “perfect silence” of the stars.

Other Solar Systems

We’ve known of most of the planets within our own solar system for centuries, but all of these objects accompany and orbit around one specific star, our sun. But since the sun is only one of innumerable other stars throughout the universe, does it not stand to reason that many, if not most or even all, of those other stars also have planets orbiting around them? As likely and reasonable as such a scenario might seem, until fairly recently we did not possess the technology necessary to verify (or disprove) it.

All this, however, is starting to change, and we have now discovered that some of the other stars with which we share the cosmos are indeed accompanied by planets of their own. The first other solar system was discovered in what could probably be considered one of the most unlikely of places: around a pulsar, the shattered remnant of what was once a star far more massive than our sun. This discovery, made with the Arecibo radio telescope in Puerto Rico and announced by Alex Wolszczan in 1992—and verified with additional observations over the subsequent two years—tells us that planets can form under some of the most extreme and hostile environments imaginable, and implies that planetary formation should be a rather commonplace occurrence in the more benign environments that accompany stars more like the sun. (Since Wolszczan’s announcement, potential planetary systems have been reported around one or two other pulsars, although none of these reports has been confirmed as of yet.)

Finally, during the past few months we’ve seen reports that some of the more normal stars in our own neighborhood are indeed accompanied by planets. Last October came the report from Michel Mayor and Didier Queloz of the Geneva Observatory that the ordinary sunlike star 51 Pegasi is accompanied by a Jupiter-sized planet orbiting fairly close in. Just this past January came the announcement by Geoff Marcy and Paul Butler (of San Francisco State University) that two more sunlike stars—70 Virginis and 47 Ursae Majoris—also are accompanied by planets that are not much larger than Jupiter. Since both these teams of astronomers—along with several others—are examining numerous other stars as part of their respective search programs, it is entirely possible that additional planets will be reported by the time this article reaches its readers.

These discoveries tell us several things. First, more or less as we expected, other solar systems do appear to be relatively common throughout the universe, and thus there is nothing particularly unique about our own system. At the same time, none of these other systems would be mistaken for a “carbon copy” of our system; all of them differ significantly from our system (and

from each other) in some of other most basic characteristics. This implies, in turn, that there isn’t even anything unique about the overall gross structure of our solar system; it would seem, once again, that there is nothing special about our system, but that solar systems can come in a variety of shapes and sizes, and that ours embodies only one particular kind of example.

As our science progresses and our techniques improve, it is reasonable to expect that at some point in the not-too-distant future we will find that, indeed, most of the stars around us have their own system of planets accompanying them. Although our experience with the recent discoveries suggests that this will not be true everywhere, it is certainly possible that around some of these stars we will find planets somewhat similar to our own Earth and, perhaps on these other “Earths” or perhaps even in

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what we might consider a less likely environment, we will find some indications that life has sprouted elsewhere. One thing seems almost certain: whatever we find will contain numerous surprises, and each discovery will serve to show that we are even less unique than we ever thought we were.

Galaxies and Galaxies Galore

Seeing is believing; while we’ve been saying for some time that there are about as many galaxies throughout the universe as there are stars within our galaxy, it’s nice to have real observational evidence to back this up. And now we have it; the so-called Hubble Deep Field (HDF), taken with the Hubble Space Telescope over a ten-day period in December 1995, shows galaxies upon galaxies upon galaxies stretching as far out in the universe, and as far back in time, as we can imagine. The HDF was exposed in a seemingly “blank” region of the sky slightly to the north of the Big Dipper’s handle, and represents an area of sky smaller than can be resolved with the unaided human eye. At least 1,500 individual galaxies—many of which are far beyond the grasp of any Earthbound telescope—have been counted within this tiny slice of sky, and if we assume that this is representative of the universe as a whole—and we have every reason for believing so—then indeed the universe contains the unac-



countable billions of galaxies that we have been postulating all along.

I urge readers to examine the HDF image and to pick out one of those tiny dim smudges for a closer look. That tiny, unremarkable patch of light is in actuality a galaxy, more or less the same size as our own, containing up to several hundred billion individual stars. It is far enough away that the light we see on this image took several billion years to get here. When we consider that this scene would be repeated almost *ad infinitum* throughout the entire vault of the heavens, we begin to realize just how large the universe really is, and how insignificant is our own little corner of it. If there is any recent discovery in astronomy that serves to give us our “lesson in humility,” the Hubble Deep Field is it.

Comet Hale-Bopp: Signs in the Night Sky

One night last July, while taking a break from one of my routine astronomical observational programs, I was fortunate enough to discover a new comet. While comet discoveries are normally not too big of a deal—up to a dozen or more are discovered every year—this comet has turned out to be a most interesting and unusual object. Comet Hale-Bopp—named after myself and an amateur astronomer in Arizona, Thomas Bopp, who discovered it at about the same time I did—appears to be intrinsically one of the largest and brightest comets that has ever been seen. When it makes its closest approach to the sun in April 1997 it may well be one of the most spectacular comets that has appeared during this century, very possibly outshining even the brightest stars in our nighttime sky.

Throughout history, the appearance of a bright comet in the

sky has often generated immense fear and trembling among many segments of Earthbound humanity, and on numerous occasions has been taken to be a sign of divine wrath and/or a portent of future catastrophic events. Even in our supposedly more enlightened society of the late twentieth century, such beliefs continue to take hold, and I have already seen several bizarre predictions as to what Hale-Bopp portends for our planet. Some of these border on the ridiculous—e.g., the comet is an alien mothership, or is at least under the control of aliens, and will strike the Earth unless we agree to be their slaves from now on—but I have also seen some more “serious” statements as to what Hale-Bopp’s appearance might mean. In particular, I have seen or heard of several claims that the comet’s appearance was foretold in several prophecies—for example, within the writings of Nostradamus—and heralds some particular dire travails our planet will experience within the forthcoming few years. I am also aware that several Christian fundamentalists have proclaimed that Comet Hale-Bopp may be one of the “signs of the end times” that are foretold within the biblical book of *Revelation*.

The comet is none of this; it will be a temporary and—we hope—spectacular addition to our nighttime skies during the first few months of 1997, but that is *all* it will be. I believe, however, that Comet Hale-Bopp presents an unprecedented opportunity for the scientists and the scientifically literate in our society to show one of the natural—not supernatural—wonders of the night sky with the rest of the public. I have reason to believe that some segments of that public may in fact be ready for such a demonstration. For example, as I finish this article, the night sky is aglow with the light of another comet, Comet Hyakutake. This object, discovered by a Japanese amateur astronomer at the end of January, is currently in the process of making a close approach to the Earth, and for the time being is putting on a spectacular shown in our northern sky. I’m somewhat gratified to see the public interest that is being directed toward this object, and the lack of mystical prognostications concerning it—although this may well be due to the short lead time we had. If we can capitalize on this interest, then the potential for an increased appreciation for science among the public could be realized.

In the long run, if we can convince our fellow human beings that the sights we see in the heavens—even something as wondrous as Comet Hale-Bopp will hopefully turn out to be—are purely natural phenomena, and that there is no need to invoke any supernatural or mystical elements as an explanation, then we will have taken a significant step toward preparing our society to deal responsibly with the technological and ethical issues with which it will be confronted during the twenty-first century. If, through the appearance of objects such as Comets Hyakutake and Hale-Bopp, we can bring our society closer to the true significance that is embodied within the first two discoveries I talked about above, then we and future generations will stand to reap enormous benefits from a more enlightened and scientifically literate public. This is an ambitious goal, to be sure, but one I believe we can’t afford *not* to strive toward. The time is ripe for such an effort, and I urge all freethinkers and rationalists who are reading this to work together with me toward bringing this to pass.