

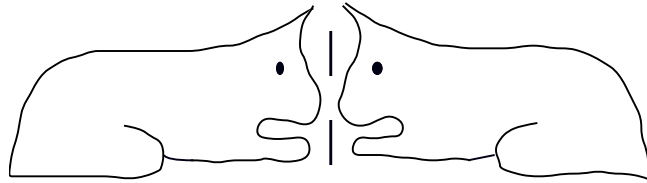


Cosmic Horizons

**Front End Evaluation Report
Working Draft
July 2000**

NSF Grant

Smithsonian Astrophysical
Observatory



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EVALUATION

The Cosmic Horizons Front End Evaluation was conducted at the Boston Museum of Science by the Lesley College Program Evaluation and Research Group staff. Staff conducted a total of 90 interviews over the course of three weeks. All groups except school groups were included in the populations targeted, as the demographics in the tables indicate. The interview protocol was developed in collaboration with Mary Dusseault (title) and was piloted before being finalized.

The method for gathering data was shaped by two factors. The first factor was the degree of importance each question held in relation to the needs of those developing the exhibit. Question one comprised a constellation of data points related to the central theme of people's ideas and understanding about the structure of the universe. This question was considered the most important to the development of the exhibit .

The second factor was consideration for visitors' tolerance for participating in interviews. Since the entire protocol consisted of 5 questions, each of which had several parts, it was decided that each interview should consist of question one and only one other question. The result was that there were 90 interviews which included question one and thirty interviews for each of the other four questions. Since many of those interviews were conducted with groups of people, the total number of people who provided information exceeded the total number of interview events. In some cases, the number of responses included in the tables total in excess of the number of interview events

QUESTION 1 ANALYSIS

Visitors were given two alternatives for answering the first question. They were asked to either draw or describe their ideas about the universe. While the majority of visitors preferred to talk about their "mental picture" of the universe, fifteen were willing to draw a picture of what they thought was in the universe. They were then asked to tell about what was in their drawing and why it was there. Some of those who drew did not elaborate much on their drawings, rendering their verbal data brief.

Although 90 people were interviewed, some people gave answers that fit into more than one category and therefore the total number of responses may exceed 90. There were several people in many of the groups who each gave a different answer.

DEMOGRAPHICS

n = 90 interviews

family/group	couples/ 2 adults	single adults	students (HS or college)
20	30	33	7

QUESTION 1.A: DO YOU HAVE A MENTAL PICTURE OF THE UNIVERSE?

Response	Freq.
Yes	65
took drawing option	15
N/A	7
No	3

DRAWING OPTION - DRAW PICTURE

Drawing Option - Draw picture		
Theme	Freq.	Sample Quotes
Facts about the universe	8	Pluto out in never never land, Universe never ends, Earth is one of the smallest planets millions of galaxies, universe always expanding.
N/A	5	N/A
Naming properties of the elements or	2	N/A

the elements or universe		
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DRAWING OPTION - LABEL THE EARTH AND ALL OTHER ELEMENTS

Drawing Option - Label the Earth and all other elements.		
Theme	Freq.	Sample Quotes
Names solar systems and some other bodies	6	<p>Moon, stars, Mars, Mercury, Venus, Neptune;</p> <p>It represents Milky Way, heavenly bodies around a core extending to infinity.</p> <p>Various solar systems, nebulae, asteroids, stars and varying magnitudes, black holes.</p>
Names parts or characteristics of the universe without mention of planets	5	N/A
See drawing (no other comment)	3	N/A
N/A	1	N/A

DRAWING OPTION - RELATIVE SIZES

Drawing Option - Relative sizes		
Theme	Freq.	Sample Quotes
Offers facts/ ideas about size	7	<p>100,000 light years, distance across a galaxy.</p> <p>Come from the planetarium. Universe is beyond comprehension in terms of size.</p>

		Can't compare it to anything you know.
N/A	4	N/A
Very little information	3	No; Difficult to comprehend; minute compared to all else
No	1	N/A

DRAWING OPTION - RELATIVE DISTANCES

Drawing Option - Relative distances		
Theme	Freq.	Sample Quotes
Offer facts	8	There may be more than one system, 10X the distance between sun and Pluto Each is 10 m miles away from each other. Jupiter is the biggest, Saturn second biggest.
Little information	7	Difficult to comprehend; long, billions of miles Don't know arrangements of what's farthest, closest;, Pluto is the farthest. Can't tell you. Earth is not closest to the sun
N/A	1	N/A

DRAWING OPTION - QUESTIONS ABOUT THE UNIVERSE?

Drawing Option - Questions about the universe?		
Theme	Freq.	Sample Quotes
Other life	6	Are we alone

		What else is out there, something similar we could interact with?
Universe theories	3	They say it's still expanding, size and distance are unfathomable Is the expanding going to continue or will it start to contract? Do the laws of mechanics work everywhere in the universe?
Other theories	3	How String Theory applies Is the Big Bang theory true
Size of universe	2	how big is it? What's on the outskirts of the universe?
Other bodies in the universe	1	Are there other planets like ours, how many stars?
Future of living in space	1	Are people going to live on Mars?
Spiritual beliefs	1	Where is heaven?

DRAWING OPTION - OTHER QUESTIONS, MORE INFORMATION?

Drawing Option - Other questions, more information?		
Theme	Freq.	Sample Quotes
Facts about the universe	9	Atmospheres within our systems Chemistry of the solar system Is there more than one sun? Is there water elsewhere

		Other universes? Harness energy of black holes? Theory--Quantum physics
Not interested	3	N/A
N/A	2	N/A
Is there life?	1	Life on other worlds, possibility of intelligent life?

DRAWING OPTION - WHERE DID YOU LEARN ABOUT THE UNIVERSE?

Drawing Option - Where did you learn about the universe?		
Source	Freq.	Sample Quotes
Elementary School	10	N/A
Television	5	Discovery Channel
Reading	3	N/A
High School or College	2	N/A
Relatives	2	N/A
Newspapers	1	USA Today mentioned
Museums	1	N/A
Bible	1	N/A

QUESTION 1.B: WHAT IS IN THAT PICTURE?

A large group of people focused only on our solar system and a somewhat smaller group knew about the 'big picture' and other parts of the universe. Another group commented on the vastness of the universe. A small number presented a spiritual view.

Question 1.B: What is in that picture?		
Theme	Freq.	Sample Quotes
Stars and Planets (focus on our solar system)	37	All the planets, stars, space, very large Star spangled sky, planets moving away from the earth Different people of different cultures, stars, planets Sun with planets revolving and moons around them
Galaxies (with no mention of planets)	24	The universe is everything
Infinite (or immense)	19	Dust, stars, we're a small part of it Big mysterious, illuminated Big, forever Vast space with many objects, too vast to even view Inconceivably large, expanding I don't know, it's unlimited The universe is an ever-expanding idiom of which we know nothing. They're just now beginning to understand.
Based on theories	4	It's the laws of nature
Spiritual	3	I will find out more when I die and go to heaven As we reach the very edge of the universe we come to the

		<p>edge of ourselves and you go into yourself. It is a journey of self-discovery.</p> <p>It has light, space, special forces coordinating everything, maybe God. Maybe everything, the whole beauty</p>
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QUESTION 1.C: HOW FAR APART ARE THE THINGS IN YOUR PICTURE?

The largest group referred to the term light-year and some reported a specific distance between bodies in the universe. A sizable group commented without specific information that objects are very far apart, that the distances are huge.

Question 1.C: How far apart are the things in your picture?		
Theme	Freq.	Sample Quotes
Measured in light years	21	<p>Many, many light years, distances are unfathomable</p> <p>There is a vastness of scale, normally described in light years</p>
Things are very far apart	17	<p>Distances are so great, you can't imagine</p> <p>Incredible distances, I don't know the scale</p>
Reported a specific distance	10	N/A
No (with no other explanation)	9	N/A
It is huge	7	N/A
Did not know	7	N/A
N/A	6	N/A
There is some scale of measurement	6	I don't know the relationship; I do see some scale of measurement

They look close in my mind	5	In my picture, they are quite close to my eye
Looks like bubbles or dots	3	In my picture you have many dots, some are faded out

QUESTION 1.D: WHAT ABOUT OTHER OBJECTS, HOW FAR APART ARE THOSE?

Most respondents stated that the concept of distance in the universe is abstract, hard to contemplate, very far or did not know. A sizable number stated an actual number as the distance between two bodies. There is an enormous difference in the knowledge of the interviewees in this area.

Question 1.D: What about other objects, how far apart are those?		
Theme	Freq.	Sample Quotes
Reported a specific distance	17	Earth is 98 million miles from the sun. Yes, I know most of those distances. We know how far apart the stars are, how many light years.
No (with no other explanation)	10	N/A
N/A	10	N/A
Huge	9	N/A
Did not know	4	N/A
Very far	4	N/A
Abstract concept	3	My life experience cannot contemplate those distances, like the time scale for rocks to form on this earth. It's a human conception of an abstract concept- sphere is not

		an accurate picture
Cannot contemplate the difference	3	N/A
Hard to explain	2	As close as they need to be; the sun and stars are very big. My thinking is not realistic about the sun and the nine planets.
It varies	1	N/A

QUESTION 1.E: HOW BIG OR SMALL ARE THE THINGS IN THE UNIVERSE COMPARED TO EACH OTHER?

As with distance, size is a concept that most respondents spoke about in general terms and referred to relative differences in size between the bodies.

Question 1.E: How big or small are the things in the universe compared to each other?		
Theme	Freq.	Sample Quotes
Different sizes, relative to each other	65	<p>Pluto is smallest, Sun is huge, Earth is small relative to the sun. I don't know about moon sizes.</p> <p>I think of the planets as marbles and the sun as a basketball.</p> <p>Some stars are huge compared to others, millions of times larger than others.</p> <p>Just that the sun is really big and other planets are significantly smaller than the Earth.</p> <p>Some suns are hundreds of times larger than our sun.</p> <p>You could line things up by size, but the scale is too large to fathom</p> <p>Size of a seed compared to size of a basketball</p> <p>The solar system is like an atom; the structure repeats itself.</p>

		<p>Everything is relative to the scale you're looking at.</p> <p>The size goes >from an infinite dot to monstrous, a complete spectrum of sizes.</p> <p>They vary in size; there is a vast range, many orders of magnitude. I've seen demonstrations of the relative size of the planets. It was done by my science teachers to scale in the schoolyard where the sun was across the street and the planets were all set up to scale.</p> <p>Relative to me, they are very large.</p>
Not sure/ Did not know	22	N/A
N/A	7	N/A
No (with no other explanation)	3	N/A
Made a specific calculation	1	N/A

QUESTION 1.F: HOW DID YOU LEARN ABOUT THE UNIVERSE?

The media, books, newspapers, magazines and television, were the most frequent responses. The Discovery Channel and Nova were cited specifically as good information sources. Most people remembered elementary school astronomy units; several referred to high school or advanced courses of study. Some reported that good information was learned by visiting the Planetarium. Those who mentioned a personal interest in the subject read science journals. Two people read the Bible and one used the Internet as a resource.

Question 1.F: How did you learn about the universe?		
Source	Freq.	Citations/ Quotes
Elementary School	31	N/A
Reading books	18	N/A
Television	18	Discovery Channel, Nova, Learning Channel mentioned specifically
Advanced education or courses	10	Mostly school, took a lot of physics, calculus and some astronomy.
Family members	10	N/A
Planetariums, museums	10	N/A
Newspapers	8	N/A
Science Journals	7	Scientific American, Smithsonian and National Geographic were mentioned most frequently.
N/A	7	N/A
Personal interest	6	I'm not a professional astronomer, but I've always had an interest about the universe and the development of the universe.
Magazines	5	N/A
Don't know	3	N/A
Encyclopedia	2	N/A
Bible	2	N/A
Research Satellite	1	N/A
Internet	1	N/A

QUESTION 2 ANALYSIS

The total number of responses may exceed the number of interviews because responses given by individuals within a group are included. Some people offered several answers that fit into more than one category and were also included. The numbers represent accurate estimates, although not precise numbers.

DEMOGRAPHICS

n=31 interviews

family/group	couples/ 2 adults	single adults	students (HS or college)
6	13	11	1

States represented: IL, MA, NY, ME, PA, GA, CT

Countries: PR, India, Korea, Netherlands, Canada, Brazil, England, Ireland

QUESTION 2.A: ARE YOU INTERESTED IN NEW DISCOVERIES ABOUT THE UNIVERSE?

Yes	Not Really
28	3

QUESTION 2.B: IS THERE ANYTHING SPECIFIC YOU'RE INTERESTED IN KNOWING?

There is an enormous range of thought regarding the question of interest in learning new things about the universe. As in all the previous questions, those people who were interviewed demonstrated a wide range of experience in thinking about the universe and in the materials they use to get information. Some people know a great deal and have very sophisticated questions based on their knowledge and experience. Some know little and have difficulty asking questions. Most of the people interviewed have

questions relating to the possibility of life on other planets in the universe. They are fascinated and somewhat overwhelmed by the thought of other life forms. Some are grateful for the expansion of knowledge as a result of the space probes. A few people seemed resentful of the large sums of money spent on space exploration and were concerned about the usefulness of the information to their lives. A few people, those who were reasonably well informed, were interested in the interpretations of the new information in relation to current scientific knowledge and theories.

Question 2.B. Is there anything specific you're interested in knowing?		
Theme	Freq.	Sample Quotes
Other life forms?	8	Are there other life forms? Whether there is life other than on the earth.
Phenomena of the universe	7	New discoveries about Black holes How old is the universe How were the Northern Lights created? Is it true about how you age in space? More about relativity, time warps, warping of space
Is the system finite? Infinity?	4	How far the system goes, the infinity of it all Are we closer to understanding the origins of the universe? What are the projections of likely outcomes of the universe? How will it end?
Usefulness of the information	3	What can be the utility of the discoveries, how can we use the information, is there a useful end? What is the return for the average person? The tests cost billions of dollars.
Space travel	3	Will there be exploration by people. Man tries and tries to get beyond where he is. Travel for everyone rather than just for astronauts.

Alternate theories	3	The measurements and observations need to be based on theories in physics in general... Actual experiences may explain the situation as well but that is not accepted, just the latest fad way of thinking. I would like someone to explain String Theory.
Anything new	2	Things that haven't occurred to us yet, that are really new.
Don't know/not sure	2	I don't know enough to even know what to ask.
Speed of scientific discoveries	1	My father had a horse and wagon and now I lived to see the airplane and space travel. I cannot even envision what they (younger people) will see in their lifetime.
Nothing	1	No.

QUESTION 2.C: WHEN YOU HEAR ABOUT A NEW DISCOVERY, WHAT DOES IT MAKE YOU THINK?

When asked about their thoughts when finding out about a new discovery, there was a range of response. Those who said they felt small were overwhelmed by the vastness of the universe, the difficulty of finding information and the enormous amount that is still unknown. Others were excited and stimulated by the expansion of knowledge and the possibilities that could be derived from the new information. Data reflected an expectation that scientific knowledge will continue to grow, that we will keep learning and that we will solve many problems. A few people commented in a spiritual area as it relates to the personal journey of their own lives and their relationship to God.

Question 2.C: When you hear about a new discovery, what does it make you think?		
Theme	Freq.	Sample Quotes

Expands possibilities	8	<p>Someone is still searching for something.</p> <p>It is good to find out new things.</p> <p>There is a whole lot out there that we know so little about.</p> <p>The discoveries of the human mind are important.</p> <p>Wow! We are getting somewhere.</p> <p>It will shatter what we believe.</p> <p>Expands my horizons and possibilities that come about with new discoveries.</p>
Exciting, interesting	6	<p>I think it is exciting, different. I like to hear about new developments</p> <p>Fantastic, I am not afraid, it is exciting</p> <p>There is still so much to know. Even then, there is still more</p>
Makes me feel small	6	<p>How small we are, how old we are getting</p> <p>We just don't know, we have to look more</p> <p>Belittling, makes me feel smaller.</p>
Relevance to daily life	6	<p>How much money did it take? How long did it take: How pertinent is it to our daily lives?</p> <p>What will be the next benefit for science, engineering or medical fields?</p> <p>I think about how much there is out there that doesn't affect me. Out there, it is a mystery to me.</p> <p>It is interesting to read about. It is hard to think of in connection to day-to-day living.</p>
Is it valid?	3	<p>How valid is the discovery? It is not always so, sometimes they jump; the gun on some stuff</p>

		Science is continually changing and what we believe to be a truth today is not necessarily a truth tomorrow.
Is this God?	2	Sometimes I start to get philosophical. Is this God?
No words	1	N/A

QUESTION 2.D: HOW DO YOU FIND OUT ABOUT NEW DISCOVERIES?

The sources most frequently used to find new information are the media; newspapers, magazines and television. Fewer people said that they use the Internet to learn more. Several people said they learn from others, parents from their grown, better educated children and young people from their parents. The Discovery Channel was mentioned specifically.

Question 2.D: How do you find out about new discoveries?		
Source	Freq.	Citations
Newspapers	21	N/A
Magazines and journals	13	New York Times Science Section, Smithsonian Magazine, Time, National Geographic, Science, Science News
Television	12	Discovery Channel was specifically mentioned
Relative or word of mouth	4	N/A
Internet	3	N/A
Museums	2	N/A
Classes	1	N/A
Meditation	1	N/A

QUESTION 3 ANALYSIS

DEMOGRAPHICS

n= 32 interviews

family/group	couples/ 2 adults	single adults	students (HS or college)
10	10	7	5

States represented: MA, ME, NY, OH, IN, MI, CA, FL, TX, KS, KY

Countries: USA, Brazil, Sweden, Ireland, Canada, India, Switzerland, France

QUESTION 3.A: ARE YOU INTERESTED IN STORIES OF HOW SCIENTISTS EXPLORE THE UNIVERSE?

Yes	Not Really
29	3

QUESTION 3.B: WHAT PART OF THEIR RESEARCH INTERESTS YOU?

Almost everyone interviewed was interested in stories of how scientists explore the universe. Relative to their level of experience, some visitors said it was important that the information not be too technical or detailed. One visitor wanted to know what motivated the scientists to specialize and thought kids could identify with that information. Other people liked hearing personal stories along with discussions of research methods, tools, new theories, and how the research could impact daily life. There was another suggestion to encourage viewer participation by providing a place within the exhibit to write questions... such as a large chalkboard... “gives the children the chance to think more freely”.

Question 3.B: What part of their research interests you?		
Theme	Freq.	Sample Quotes
Life on other Planets	7	<p>We're always curious – life on other planets, etc. the earth is a small part of the universe.</p> <p>How we relate to the universe. Are we alone? What's our role...helps us understand ourselves.</p> <p>Possibility of life elsewhere. Life is not always the same.</p>
New hypotheses and ideas	7	<p>Especially ideas that are different from the norm.</p> <p>Sending out probes to another planet</p>
All aspects of space	5	<p>It's all exciting. Almost everything. They're studying all aspect of space; theory of relativity.</p> <p>When they talk about the planets – Mars, Jupiter</p> <p>How can human beings reach the stars?</p> <p>Nuclear physics. How does the universe work?...fusion between two atoms of hydrogen explain the sun. We must find theories to try to explain—maybe the theories will change; the questions will grow.</p> <p>Everything. Are they capable of exploring a lot more than they have?</p>
Personal motivation	4	<p>Whole story; what got them interested and then the end result."</p> <p>How they became interested and how they were encouraged</p> <p>Their method of study; biographical so kids could identify</p>
Multiple theories of the universe	5	<p>Is there a third dimension? Black hole theory</p> <p>The Creation – make that understandable as an exhibit/those first milliseconds; suggests viewers participation – place within exhibit to write—children can</p>

		<p>think more freely. What happened at the Big Bang?</p> <p>Their discoveries and the build up to them "when things fall into place. Looking at the universe from not only a scientific point but religious, spiritual point of view</p> <p>How much matter and is it expanding or contracting</p>
Tools	2	<p>Gadgets. Telescopes, space stations...machinery.</p> <p>We've been able to see more things with telescopes, computers, satellites</p>
N/A	2	N/A
Hands -on	1	N/A
Applications of research to daily life	1	Anything that's applicable to me – climate wise, health, travel wise
Pure math	1	Most people don't like that kind of reading.
Ecological destruction	1	Space stations, etc. But scary—what destruction will it bring to us?

QUESTION 3.C: IN YOUR MIND, WHAT ARE SOME OF THE DIFFICULTIES SCIENTISTS FACE IN RESEARCHING THE UNIVERSE?

A majority of those interviewed cited the difficulties of obtaining funding, getting past the entrenched theories, the vastness of distances yet to be explored, the limits of instrumentation, and not least of all— the Time factor. Life is so short.

Question 3.C: In your mind, what are some of the difficulties scientists face in researching the universe?		
Theme	Freq.	Sample Quotes
Money for funding	19	<p>Unless the society honors what they're doing, funding is difficult. And hopefully the research isn't just going where the money is.</p> <p>Questions spending a great deal more on possibly unnecessary explorations</p> <p>Entrenched theories</p> <p>Nobody really cares anymore</p> <p>Breaking through the Industrial monopolies</p> <p>Don't shut down SETI</p>
Distance	7	<p>Lack of powerful enough computers or access to them</p> <p>Long distances to explore other galaxies</p>
Limits of technology	7	<p>Limitation we have as humans to get us more accurate information. Limits of instrumentation, being able to do more space travel.</p> <p>No oxygen, water</p> <p>Difficult to get into the right mindset compared with ordinary thinking</p> <p>Being able to stay in space long enough to gather info</p> <p>Gravity</p> <p>The universe is very big, very old...without proper equipment to see through the earth's atmosphere. Atmosphere itself is acting as a filter</p>
Limits of time	4	<p>Life is too short to explain the mysteries and to comprehend how it works. Not enough time to observe, to have enough info. You can only have a partial view in a lifetime...the</p>

		sizes, distances. The size is bound with the time. Sizes are so unbelievably big.
Low interest in science	4	Getting over the hurdle of all the ignorant people I didn't learn enough to sustain my interest or to understand Lack of students pursuing the field Convincing the public it's worthwhile
Pollution	2	Observatories have a lot of atmospheric interference City lights
Getting past the failures	2	Such as the Mars satellite that never worked Apollo
Research Methods	2	What causes scientists to ask the questions they do, and then how do they test those questions? What things do they look for? How long does it take? Not being able to actually be there.
Competition among countries	1	Hostilities from different parts of the world where the scientists might be doing research
Origins of universe	1	N/A

QUESTION 4 ANALYSIS

All cultures through human history have developed theories and stories to explain how the universe began, why we are here and reflect on whether the universe changes.

DEMOGRAPHICS

I conducted 30 interviews, however, many responses fell into more than one category. Therefore, the total number of responses is greater than 30 for parts A and B.

n= 30 interviews

family/group	couples/ 2 adults	single adults	students (HS or college)
5	9	15	1

QUESTION 4.A: WE ARE INTERESTED IN HEARING WHAT YOU KNOW ABOUT SOME OF THE THEORIES AND STORIES INCLUDING SCIENTIFIC THEORIES.

Respondents cited both scientific and spiritual/ cultural stories related to the creation of the universe and our purpose for being here. The majority of individuals expressed some knowledge of Big Bang theory, as well as stories from church, and the Bible. Approximately 16 respondents expressed a belief in God or a higher power, while 10 specifically did not, citing scientific theories as the basis of their beliefs. Many of those with a religious/spiritual orientation integrated Big Bang or other scientific theories into their belief system. Some with a “rational orientation” clearly stated they did not believe in Creationism or the Biblical stories related to the formation of the universe. Those who referred to Creationism seemed to consider it a term for a God-created universe, but not necessarily a strict interpretation of the biblical story of creation.

Category headings are based on visitor responses to part one; some individuals who mentioned the Big Bang did not believe in it; many who mentioned myths or God concepts did not adhere to those stories or concepts.

Question 4.A: We are interested in hearing what you know about some of the theories.		
Theme	Freq.	Sample Quotes
Big Bang Theory	24	<p>Big Bang Theory...it's expanding and will collapse eventually.</p> <p>The Big Bang-I don't believe it.</p> <p>Science and religion both say Big Bang, they debate what the Big Bang was.....</p> <p>Big Bang, the Earth began 12-20 Billion years ago.</p>
Creationism/God, Spiritual/Religious	22	<p>There can be both religion and scientific. I've read many books, many scientific theories can be integrated with religion.....</p> <p>...God may have started the Big Bang. I don't have a problem with the progression from amoebae and God.</p> <p>I believe there's God, he started the universe, that got matter going.</p> <p>I believe it's a created universe</p> <p>I believe in a greater force-something started the growth process and growth takes its' own force</p>
Other scientific theories	15	<p>I subscribe to Evolution and that God took a part in it.</p> <p>I've heard of string theory and others, but it's hard to understand.</p> <p>I've read Stephen Hawkings' theory of the universe; it's new....</p> <p>I believe science can explain what religious people call spiritual...for example, some tribes thought volcanoes were gods.</p>
Folk theories/myths	6	<p>Egyptians were interested in astrology, their religion was based on that....(cites other cultural stories including</p>

		Polynesian, Stonehenge, Babylonian). There's an Indian myth about the Big Turtle, various myths. also Hindu/Buddhist--the universe as a cycle. Instead of expanding or contracting, they believe it starts over.
No answer/ don't know	2	N/A

QUESTION 4.B: CAN YOU TELL WHERE THESE IDEAS COME FROM?.

Respondents cited school, books and family as major influences. Schooling and reading featured prominently in learning about scientific concepts, along with visits to museums and contact with Scientists. Religious education, family/upbringing and the Bible were the source of religious beliefs and concepts. Some visitors gave specific sources, such as the Discovery Channel or Carl Sagan's writings on evolution; a number mentioned Stephen Hawkings. Visitors usually gave answers which fell into multiple categories, as shown below.

Question 4.B: Can you tell where these ideas come from?		
Source	Freq.	Citations
Reading	17	Generally related to scientific books and magazines
School	15	N/A
Religious Education/Church	13	N/A
Family/Friends	7	N/A
TV/Media/Movies	6	Popular culture, including science fiction was mentioned by several visitors.
Scientists/Museums	6	N/A

No answer	1	N/A
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QUESTION 4.C: SCIENTISTS STILL HAVE QUESTIONS ABOUT WHERE THE UNIVERSE ENDS. WHAT ARE YOUR THOUGHTS ABOUT THIS?

Most respondents did believe the universe was infinite. Many visitors had difficulty expressing their view of infinity or stated that the whole idea was beyond comprehension. They frequently cited the “vastness” of the universe; some believed a search for an end was pointless, since it was impossible to find. Two individuals indicated they don’t think about the issue; they are focused on events closer to home.

Generally, responses fell into the categories listed below, with more than one-quarter of respondents feeling unsure about an answer to the question. A few visitors believed the universe had an end of some type, while a small number stated that the universe may be circular, and “wrap in on itself.” The following comments express the respondents’ awe and various beliefs relating to the topic of infinity.

Question 4.C: Scientists still have questions about where the universe ends.		
What are your thoughts about this ?		
Theme	Freq.	Sample Quotes
Infinite Universe	11	<p>...right now it seems there’s no end. It’s a matter of discovering what kind of dark matter and how much.</p> <p>It ends when all the molecules go back to their original position.</p> <p>I define the universe as never-ending. They’re looking for more but there isn’t, we’re all one, everything is together.</p>
Not sure	8	<p>No opinion. I don’t know, it’s not our job to figure out everything...</p> <p>I’ll leave it to Science to decide. One theory says the universe will expand forever, another says the universe will contract. I think the first theory has more empirical support. To me it’s a question of scientific study.</p>

Beyond comprehension	6	<p>Beyond what we can understand. Our minds can't understand infinity.</p> <p>I think human understanding is limited. We can't see beyond our preconceptions and prejudices.</p>
Not infinite	3	I think it has an end...in terms of space.
Don't think about it	2	I don't think about this...I think about the Earth, homelessness, gun control, stuff here and now.

QUESTION 5 ANALYSIS

Some responses fell into more than one category, in which case the dominant category was chosen.

DEMOGRAPHICS

n = 31 interviews

family/group	couples/ 2 adults	single adults	students (HS or college)
10	10	9	2

6 college students were also included in other groups

Includes 12 international visitors

QUESTION 5.A: DO YOU COME AWAY FROM THIS EXHIBIT WITH ANY QUESTIONS?

In addition to numerous comments about the exhibit, question 5 part one elicited a great amount of information reflective of visitors' concepts about the world around them and the questions which arise based on these concepts.

While a number of visitors said no questions came to mind, the majority did have questions and concerns. Since question 5 was connected with a particular exhibit, respondents who spent more time in the planetarium area, and who viewed the exhibit more thoroughly seemed to consider cosmic issues more seriously.

Many of the questions focused on the origin of the universe. Some respondents were more concerned with the Solar System-primarily the earth and the planets, and not as concerned or aware of other elements of the universe. These individuals were interested in how the Earth was created, and the formation of the other planets. Related comments centered on how mankind began, and how long the process of creation had taken. A sizable number of visitors were interested in how the universe was created and what other elements exist, including many yet to be discovered.

The size of the universe effected patrons' views of their place in the world. About one-fifth of respondents remarked on the Earth's insignificance, and a sense of mankind as "tiny/insignificant."

Finally, some answers to part one focused specifically on exhibit features and design. A number of patrons expressed a desire for moving parts, and possibly a walk-through exhibit to promote their understanding of the ideas shown in this exhibit.

Question 5.A. Do you come away from this exhibit with any questions?		
Theme	Freq.	Sample Quotes
No answer or nothing in particular	9	I think I knew quite a bit going into it, I'm forty-something, you learn quite a bit.
Scale/size of universe	6	<p>We are very small</p> <p>The only thing is the relationship size-wise to the universe...it (Earth) seems so insignificant. I guess we're finite little creatures.</p> <p>One question is where are we in each exhibit...I think about the size, how big this is in real life. I think about the size of the universe and the closest star in the universe and to show the distance is amazing.</p> <p>It makes me feel really little in the whole big picture-people in general...We think we're so important--spiritually, philosophically however you look at it.</p>
Exhibit features/depiction	6	<p>It's understandable, you have to go from one end to another. You start from the Earth and go out into the universe.</p> <p>I looked at the Solar System--Why didn't you show all the planets in orbit and the satellites...not just the rings, with the stars--are they moving or not?</p> <p>I wondered if it (the exhibit) was an exact display-is the Earth in the right place mathematically? Are there other galaxies?</p> <p>The exhibit was a little confusing. The visual was nice, but a 3-D kind of thing would be more understandable.</p>

<p>Origins of the universe</p>	<p>5</p>	<p>How is the Earth made, what is it made of and how did it form?</p> <p>How long it took to make the Earth</p> <p>How did it all start? How did the Earth and mankind start? How is it gonna end? What do scientists think will happen?</p> <p>I have questions on how it started up..exactly how the universe started, where it came from?</p>
<p>Location of other galaxies</p>	<p>5</p>	<p>It makes you wonder what else is out there-we're a tiny thing in this huge galaxy.....I'm curious about the void. You always question what you don't know.</p> <p>...we're at the edge of the Milky Way, so do we see other stars-you could explain what a light year means in time and space.</p>

QUESTION 5.B: WHICH OF THE EXHIBIT FEATURES STAND OUT IN YOUR MIND?

In comments related to the question “Which exhibit features stand out in your mind?” some visitors had no comments. It should be noted that this exhibit received the most visitors shortly before a Planetarium show, and many visitors glanced at the displays in a cursory manner. Many visitors had suggestions as to how to improve the exhibit; some expressed frustration over features that did not work. For example, a number of lights which indicated the position of the Earth were not working. A few respondents specifically mentioned the “boxed displays” as presenting a false impression of an infinite universe. They believed that this representation was misleading and seemed finite.

A few patrons shared new learning they had discovered from the displays. Finally, the exhibit stimulated cosmic questions for some visitors; these individuals commented on the vastness of our universe and how small the Earth is in comparison to the universe.

<p>Question 5.B. Which of the exhibit features stand out in your mind?</p>		
<p>Theme</p>	<p>Freq.</p>	<p>Sample Quotes</p>

Desired features/ changes	18	<p>lights for our location are burned out or hard to see</p> <p>The real orbits of the planets are elliptical-this shows circular orbits. Also this electrical display doesn't give the exact correct impression (referring to solar system display).</p> <p>If I see this I think I understand the universe, but it's not true, because this image of the universe is presented as the whole universe...it's not possible to see all of it.</p> <p>Some of the buttons, what's it mean, what's the concept?</p>
No answer	6	N/A
Cosmic questions	4	<p>There's a lot of different things, like the milky way and the galaxy clusters, so many parts of outer space.. it's scary bizarre, like I remember talking in class--What if there's another universe?</p> <p>...we're at the center of this moving mass of stuff. We don't think about it in daily life.. it's funny to think of old theories that we're at the center of everything, now we know we're very much not.</p> <p>It gives an impression and where things are-Solar System, and how small we are." "How insignificant we are...yes, in comparison.</p>
New information	3	<p>I didn't realize how many different galaxies there are-that we know about.</p> <p>Why do they call it the Milky Way?...when did people refer to it that way?</p>

QUESTION 5.C: WHAT THOUGHTS DO YOU HAVE ABOUT INFINITY?

Most visitors found the concept of infinity to be both fascinating and difficult to grasp. A large majority of visitors who expressed an opinion believed the universe was infinite; some felt certain of this belief while others were more uncertain. Many visitors indicated that the concept of infinity was difficult or impossible for them to grasp, as was the size of the universe. The theme of the vast universe and mankind's small presence was mentioned by some patrons. God and a sense of spirituality influenced the views of visitors who talked of "a mighty hand" and a belief that God created the

universe. These individuals seemed generally interested in scientific explanations on this topic. Additional comments were offered that related to the presentation of this exhibit, though less information was provided than in part two of this question.

Question 5.C. What thoughts do you have about infinity?		
Theme	Freq.	Sample Quotes
Ungraspable/ infinite universe	15	<p>Yes, after seeing that (the exhibit) it goes on forever.</p> <p>We keep finding more things, so we can't say it is finite. Anything that is not finite is infinite.</p> <p>The whole idea of how it started like Big Bang, I grapple with that, it's so impossible to me, it's an amazing thing. I can't totally grasp it.</p>
Effects on personal view/ place in the universe	7	<p>I think the last one...You are here.. such a small part of such a great cosmos-the last one hits you I think.</p> <p>The vastness of it-the whole universe and how tiny a part of it we are.</p>
Spiritual views/ God	5	<p>Who knows what mighty hand holds it together</p> <p>Are we the only planet-of all the planets, why do we have life here? It's like death, you don't know till you've been there.</p> <p>Yes, God created the universe-it goes on and on-as far as we know, it doesn't end.</p>
Exhibit comments	4	<p>The exhibit (with boxed displays) looks finite-the universe is infinite.</p> <p>The exhibit gives an impression of beginning and end-it's a contained exhibit-I see the universe as infinite.</p>