Universe
of
Wonders

Scientific Evidence for Creation

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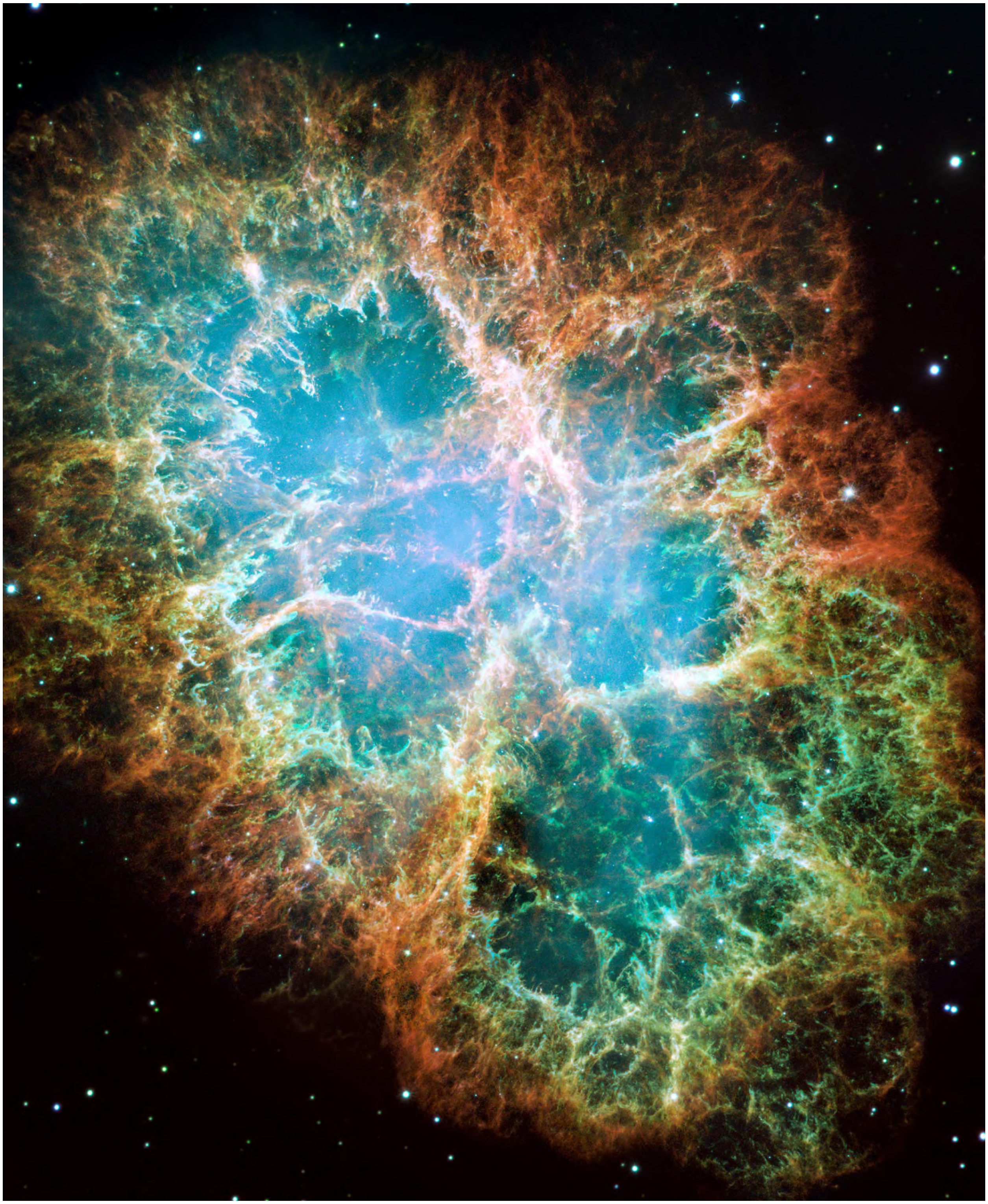
Introduction

Our universe is filled with elegant details, awesome workmanship, and great wonders. The interactions of these great wonders are orchestrated in layers and staged like a Broadway play. The layers of wonder and complexity in the universe build on top of each other: each layer becomes a building block for yet another higher layer of complexity and structure. Engineering, craftsmanship, and artistry scream out at each layer. The universe is not only complicated, but it is also a truly strange puzzle. The famous astronomer Sir Arthur Stanley Eddington[1] is often given credit for the statement, "Not only is our universe stranger than we imagine, it is stranger than we can imagine."

On July 4, 1054, the universe revealed[2] a piece of the puzzle. The night sky was lit up by an exploding star that was brighter than a hundred billion stars. The light from this fabulous explosion has been fading for more than nine hundred and fifty years. The light has faded from fabulously super bright to merely just super bright. The faded remains of this star are shown in stunning detail in the picture on the next page.



Crab Nebula

At first the exploding star was so bright that it could be seen day and night for twenty-three days. Nine hundred and fifty years later, the super heated remains of this huge explosion are still flying through space, and they are still a bright spot for telescope users around the world. This type of explosion is called a supernova, and this particular exploding star is called the Crab Nebula.

How can such things happen in our universe? The more I study, the more I am stunned. As I began to share my insights with friends and relatives, they saw what I saw and were amazed. This book is a big-picture overview of the universe with details about the things I have found to be intriguing or amazing. I hope that you, too, can see the wonders that my friends and I have seen.

I will describe the universe in layers, and then I will give additional details about my favorite layers or parts. The layers have precise standards, intricate patterns, and interchangeable parts. By describing the universe in layers, I hope to provide you with a stepwise approach to understanding what is known about our universe. Knowledge of each layer helps to reveal information about the higher layers. I do not describe a lot of "new" information. I have simply staged what is now known about the universe in a way that I find easier to understand.

Once you understand the structure of the universe, it will be easier to appreciate that it is truly incredible. Many of the wonders of the universe may be seen with your eyes. Other wonders cannot be fully appreciated until you understand what really makes things work. The Multiple Layers section below is an overview of the multiple layers of wonder, complexity, and design in the universe.

Multiple Layers of Complexity

I have chosen nine layers or divisions to show the building-block nature of the universe. These divisions are somewhat arbitrary, but I find them helpful. The layers are numbered from one to nine, where one is simple and nine is complex. The following list has the simple layers at the bottom and the complex layers at the top, similar to the building-block pyramid on the next page. Here are the nine layers of engineering, craftsmanship, and artistry that I have found in our building-block universe:

9. Process Control and Quality Control
8. Molecules that Make Molecules
7. Blueprints
6. Big Molecules for Life
5. Medium Molecules
4. Simple Molecules
3. Atoms, Stars, and Light
2. Subatomic Particles
1. Fundamental Particles

Chapters one through nine are devoted to these nine layers of complexity. Chapter ten highlights miscellaneous layers of complexity. Layers seven and nine are not physical layers of complexity, but they are layers of information and control. Each higher building-block layer is assembled from the building blocks in the layers below it. In this way each layer of complexity becomes a building block for yet another higher layer of complexity and structure. The pyramid on the next page visually illustrates the layers of the building-block universe.

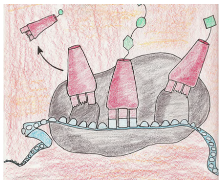
Details for the Building-Block Pyramid

The entire physical universe is made of the twelve fundamental particles that are listed in the bottom layer of the pyramid. Chapter one provides details about the twelve fundamental particles. Chapter two covers electrons, protons, and neutrons, which are illustrated in the second building-block layer of the pyramid. Protons and neutrons are made from up quarks and down quarks. The electron is one of the twelve fundamental particles, and it is also one of the building blocks for atoms. It is included in both the first and second layers. Hydrogen atoms, carbon atoms, and nitrogen atoms are shown as examples of simple atoms in building-block layer three. Observe that atoms are composed of protons, neutrons, and electrons. Simple molecules like carbon dioxide, ammonia, and water are made of atoms, as illustrated in building-block layer four. For example, one water molecule is made from two atoms of hydrogen (“H”) and one atom of oxygen (“O”). In the stick figures used to portray molecules on layers four, five, and six, “C” represents a carbon atom, “H” represents a hydrogen atom, “N” represents a nitrogen atom, and “O” represents an oxygen atom.

9. Process Control and Quality Control

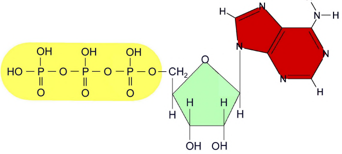
8. Ribosomes are molecules that make molecules. Ribosomes are made of RNA and proteins.

Ribosome inside a cell →

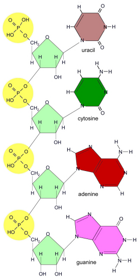


7. Information stored in DNA Blueprints

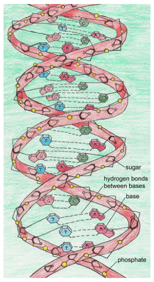
6. Big Molecules for Life



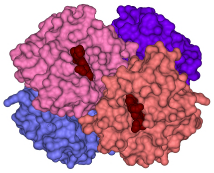
ATP



RNA

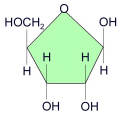


DNA

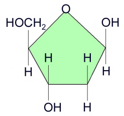


Proteins

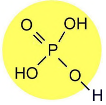
5. Medium Molecules



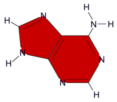
Ribose



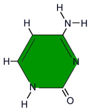
Deoxyribose



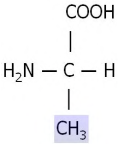
Phosphate



Adenine

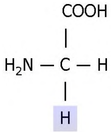


Cytosine



$$\begin{array}{c} COOH \\ | \\ H_2N - C - H \\ | \\ CH_3 \end{array}$$

Alanine



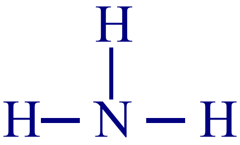
$$\begin{array}{c} COOH \\ | \\ H_2N - C - H \\ | \\ H \end{array}$$

Glycine

4. Simple Molecules

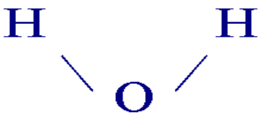
O — C — O

Carbon Dioxide



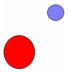
$$\begin{array}{c} H \\ | \\ H - N - H \end{array}$$

Ammonia

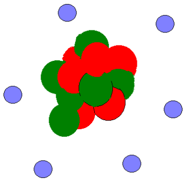


Water

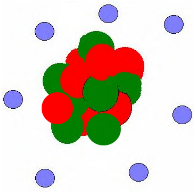
3. Atoms



Hydrogen



Carbon



Nitrogen

2. Subatomic Particles

Electron ● Proton ● Neutron ●

1. The Twelve Fundamental Particles	up quark, charmed quark, top quark, down quark, strange quark, bottom quark, electron, muon, tau, electron neutrino, muon neutrino and tau neutrino

Nine Layers of the Building-Block Universe

The following examples of medium molecules are shown in building-block layer five:

- Ribose sugar and deoxyribose sugar
- Phosphate (H_3PO_4)
- Adenine and cytosine, which are two of the five nitrogen-containing bases used to make deoxyribonucleic acid (DNA) and ribonucleic acid (RNA)
- Alanine and glycine, which are two of the twenty amino acids needed to make proteins.

Building-block layer six has four examples of big molecules for life: adenosine triphosphate (ATP), ribonucleic acid (RNA), deoxyribonucleic acid (DNA), and an example protein (hemoglobin). Hemoglobin is just one of the many thousands of different proteins found in living things. The first molecule on the left is ATP. ATP is made from three phosphates, one ribose sugar, and one adenine molecule, as may be seen by comparing the ATP molecule in building-block layer six with the medium molecules in building-block layer five.

Building-block layer eight has a figure of a ribosome inside a cell. Ribosomes are made of RNA and proteins[3]. Cells use ribosomes to assemble proteins. After I describe the building-block structure of the universe, I will evaluate the claims of random chance advocates and the evidence for creation.

If your background in chemistry is weak, note 4 on page 97 will help you understand the structure of molecules in layers 5 and 6.

Chapter 1
Fundamental Particles

The first layer of wonder and complexity in the universe, and the foundation of the physical universe as we know it, is the twelve fundamental particles. These twelve particles are used as building blocks to make protons, neutrons, and all of the atoms in the universe. Every physical thing in the universe that may be seen with the eyes or touched with the hands is made from just twelve types of fundamental particles. This does not include items like antimatter and "dark matter," which cannot be seen.

One of the twelve fundamental particles is the electron. Six of the twelve fundamental particles are quarks. The twelve fundamental particles[1] are shown in the table below as listed in the Standard Model.

The Twelve Fundamental Particles

Up quark	Electron
Charmed quark	Electron neutrino
Top quark	Muon
Down quark	Muon neutrino
Strange quark	Tau
Bottom quark	Tau neutrino

Research on fundamental and subatomic particles is conducted at Brookhaven National Laboratory on Long Island in New York. Gold atoms are accelerated to high speeds (more than 180,000 miles per second) and carefully aimed to smash into each other. The collisions are so violent that atoms break into small pieces. A large detector is used to identify the pieces of the smashed atoms. In this way scientists are able to study the particles used to make atoms.

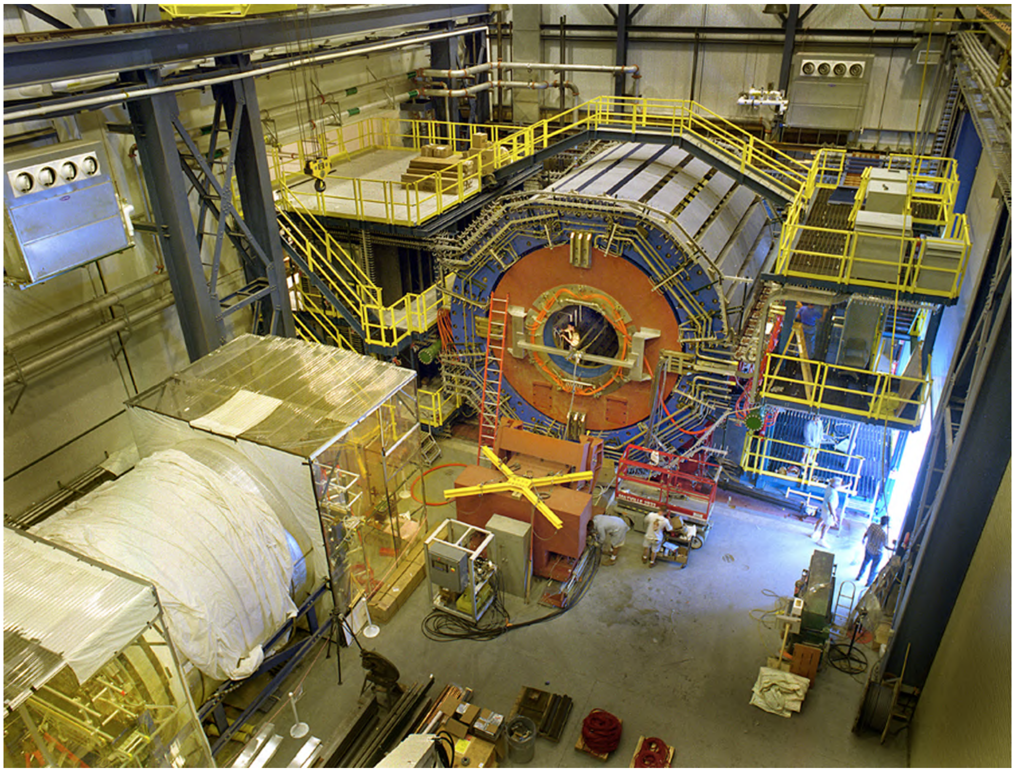
Four photographs are shown on the next two pages. The round outline of the huge particle accelerator is clearly visible at the top of the first photograph. The particle accelerator is essentially a large circular tube that is two and one half miles around. It uses magnetic fields to accelerate ionized gold atoms to high speeds. The second photograph shows a close-up view of a small part of the tubular accelerator. The third photograph shows the particle detector. The fourth photograph shows the pieces produced by the violent collisions of the gold atoms.

Courtesy of Brookhaven National Laboratory

Brookhaven National Laboratory on Long Island in New York

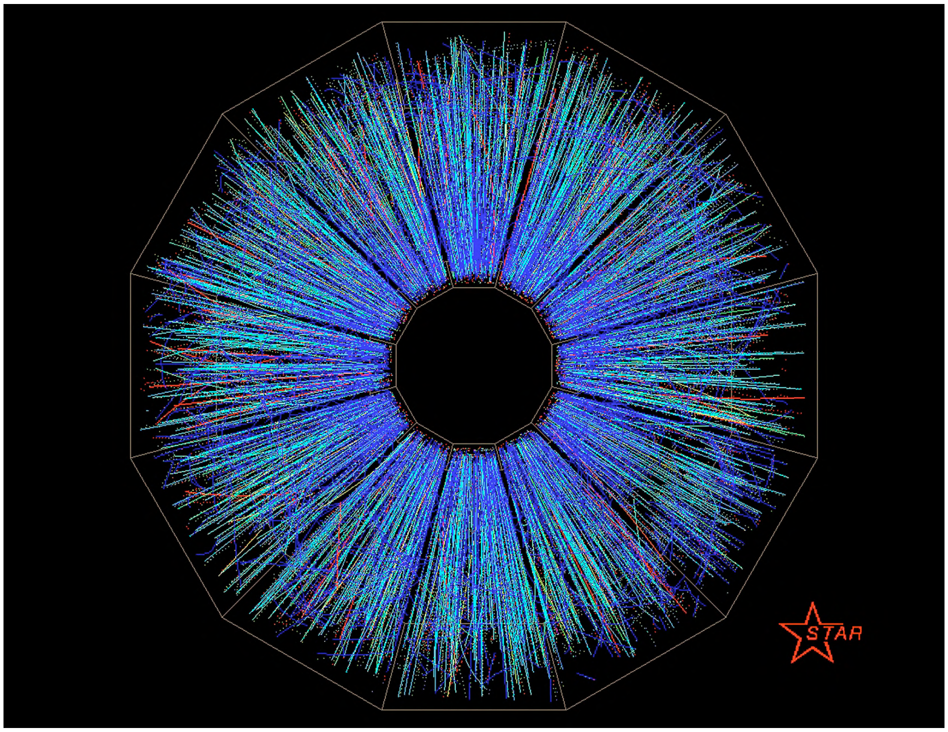
Courtesy of Brookhaven National Laboratory

Gold atoms smash into each other at high speeds inside the big tube.



Courtesy of Brookhaven National Laboratory

The particle detector is blue and orange on the front side.



Courtesy of Brookhaven National Laboratory

The remains of the smashed gold atoms

Twelve

The physical universe is made from twelve fundamental building blocks. Twelve is a number that often shows up when the God of the Bible is building:

- The nation of Israel[2] was composed of twelve tribes.
- Jesus Christ started the church[3] with twelve apostles.
- Holy Jerusalem[4] as described in the New Testament book of Revelation has twelve gates and twelve foundations.

The number twelve provides a small amount of evidence that the God of the Bible is also the God of the Universe.

Chapter 2
Subatomic Particles

The second layer of wonder and complexity in the universe is subatomic particles. Subatomic particles are, as their name implies, smaller than atoms. Protons and neutrons are subatomic particles but not fundamental particles because they may be broken down into smaller particles. Protons and neutrons are composed of fundamental particles[1] called quarks. Two up quarks and one down quark are used to make a proton. Two down quarks and one up quark are used to make a neutron as summarized in the table below:

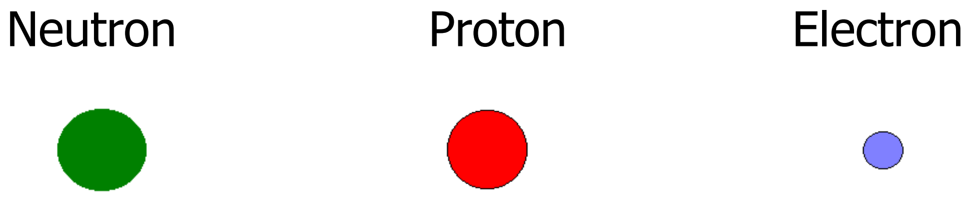
Parts List for Protons and Neutrons

Subatomic Particle	Up Quarks	Down Quarks
Proton	2	1
Neutron	1	2

Electrons are classified as both subatomic particles and fundamental particles because they are smaller than atoms and they cannot be divided into smaller particles.

This chapter focuses on just neutrons, protons, and electrons because these are the three subatomic particles that are used to make atoms. These three particles are shown in the figure below and will appear in other parts of the book to show the structure of atoms. Atoms are discussed at length in chapter three.

Subatomic Particles



Neutrons and protons are nearly equal in size and mass. They are much heavier than the lightweight electrons. One proton has the same mass as about 1,836 electrons. Protons have a positive electrostatic charge, and electrons have a negative electrostatic charge. The neutrons, as their name implies, are neutral and have no charge. Neutrons and protons are bound together in the center of an atom by powerful forces to form the nucleus of an atom.

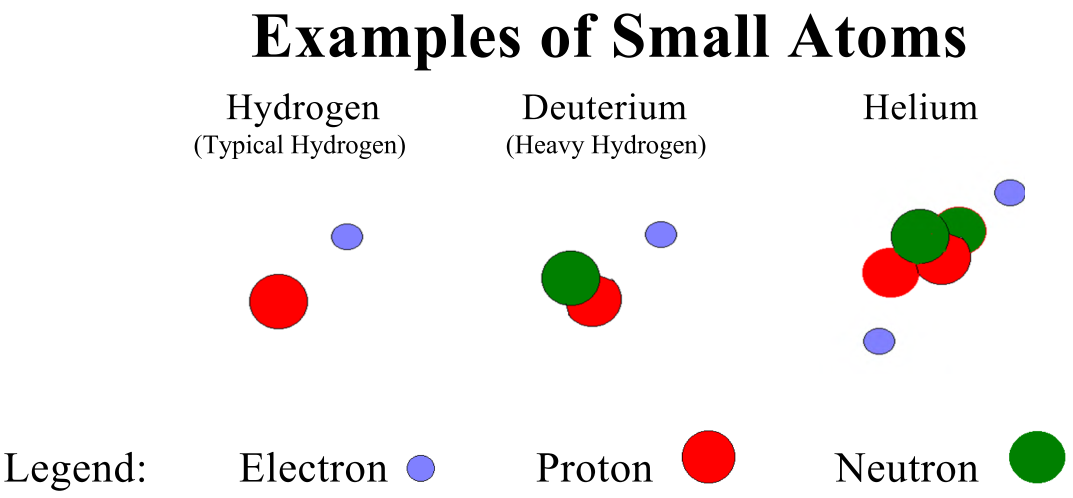
Chapter 3
Atoms, Stars, and Light

Atoms are the third layer of wonder and complexity in the universe. The protons, neutrons, and electrons described in chapter two are used as building blocks to make atoms. Everything in the universe that may be seen with the eyes or touched with the hands is composed of atoms.

The story of atoms is tied very closely to the story about stars and light. Stars combine small atoms to make bigger atoms, and this process generates large amounts of energy and light. This chapter will begin with a section about atoms and then move to a discussion about how stars use small atoms as fuel to make larger atoms and fabulous amounts of light.

Atoms

Atoms are made from electrons, protons, and neutrons. The simplest atom, hydrogen, is made when a single electron settles into a stable orbit around a single proton. The middle of an atom is called the nucleus, and electrons revolve around the nucleus just like the Earth revolves around the sun. All atoms with one proton in the nucleus are classified as hydrogen atoms. An atom with a proton and a neutron bound together in the nucleus and one orbiting electron is a type of hydrogen called deuterium. All atoms with two protons in the nucleus are classified as helium. Typical helium atoms that are used to fill party balloons are each made of two neutrons, two protons, and two electrons. Examples of small atoms are shown below:



Atoms are somewhat like small models of our solar system. The electrons revolve around the nucleus of an atom similar to the way planets revolve around the sun. The sun is much more massive than the planets that revolve around it, and likewise the nucleus of an atom is much heavier than the electrons that revolve around it. The mass of the sun is about 750 times greater[1] than the total mass of all the planets. The nucleus of a typical carbon atom has a mass that is about 3,600 times greater than the total mass of all the electrons that revolve around it. The table below shows the parts needed to assemble several of the smaller atoms.

Parts List for Several of the Smaller Atoms

Atom	Neutrons	Protons	Electrons	Atomic Number	Atomic Mass Units[2]
Hydrogen	0	1	1	1	1.007825
Deuterium	1	1	1	1	2.0140
Helium 4	2	2	2	2	4.0026
Beryllium 8	4	4	4	4	8.0053
Carbon 12	6	6	6	6	12.000000
Carbon 14	8	6	6	6	14.003241[3]
Nitrogen 14	7	7	7	7	14.00307
Oxygen 16	8	8	8	8	15.99491

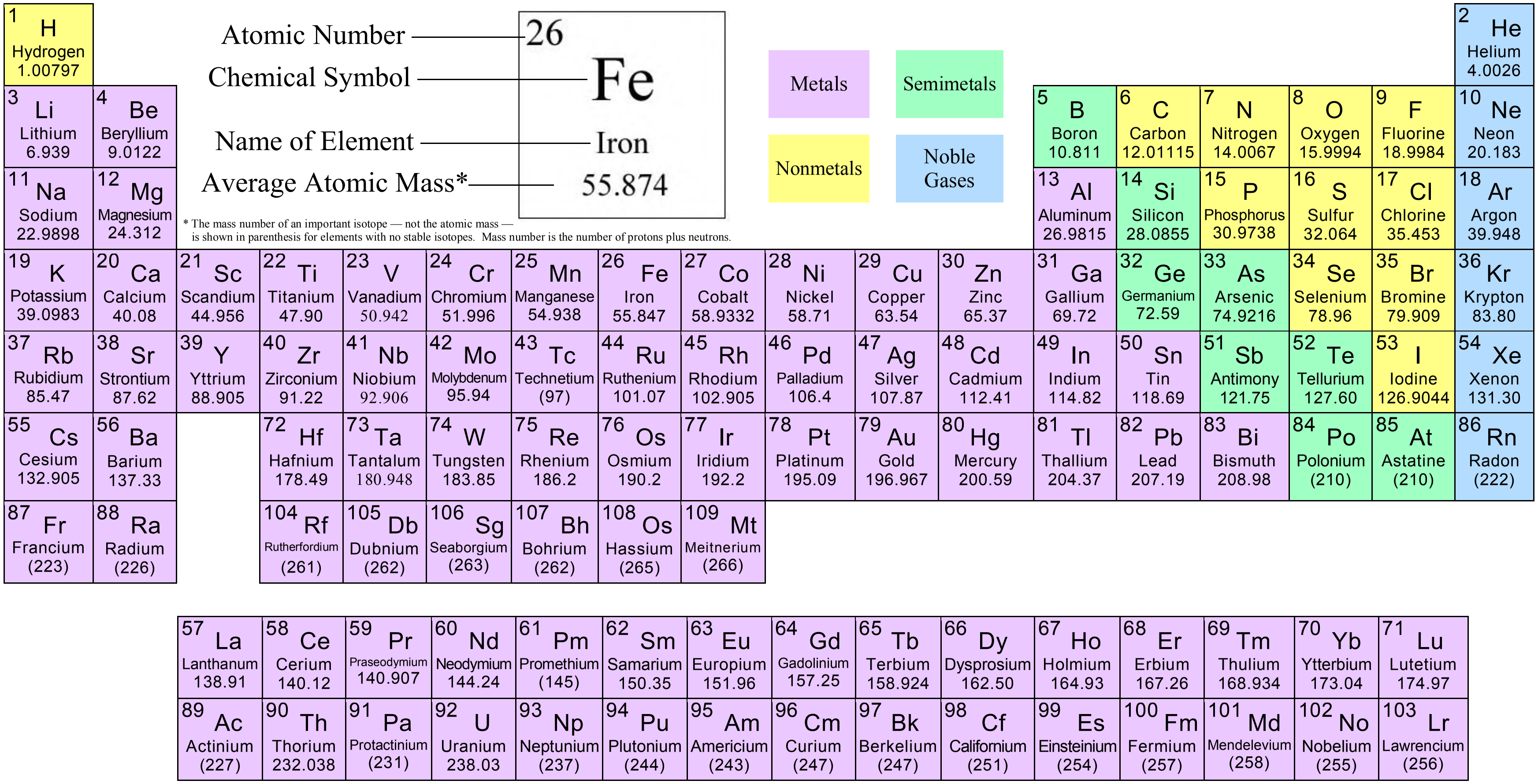
The atomic number of an atom indicates the number of protons in the nucleus. The mass of atoms is given in atomic mass units where one atomic mass unit is defined to be equal to one-twelfth of the mass of a carbon 12 atom. Notice that the mass of each atom is approximately equal to the number of protons plus the number of neutrons. The chemical properties of atoms are determined largely by the number of protons in the nucleus of the atom.

An element is a substance composed of atoms that all have the same atomic number. Each element has a lengthy and precise set of properties or characteristics. All atoms with six protons in the nucleus have an atomic number of six and are classified as the element carbon. All atoms with seven protons in the nucleus have an atomic number of seven and are classified as the element nitrogen. Atomic mass variations within an element occur when some atoms of the same element have different numbers of neutrons. These variations are classified as isotopes of the element. Carbon 12 is an isotope of carbon with six protons and six neutrons in the nucleus. Carbon 14 is an isotope of carbon with six protons and eight neutrons in the nucleus. An atom of carbon 14 is unstable. One of its neutrons may release an electron in the form of beta radiation and transform itself into a proton. The transformed atom contains seven protons and seven neutrons and has become a nitrogen atom, as shown in the table above! This transformation process is called radioactive decay. The radioactive decay of carbon 14 is very systematic and is often used to date objects that are thousands of years old. This process is called carbon dating.

Periodic Table of the Elements

Properties of atoms for more than one hundred elements have been meticulously studied and organized by scientists. A periodic table[4] of the elements is shown below. Each small box contains the name of an element, the chemical symbol, the atomic number, and the average atomic mass for the atoms of the element. The average atomic mass is a weighted average of the atomic isotopes for each element. All of these atoms are made from protons, neutrons, and electrons.

Periodic Table of the Elements



* The mass number of an important isotope — not the atomic mass — is shown in parenthesis for elements with no stable isotopes. Mass number is the number of protons plus neutrons.

1 H Hydrogen 1.00797																	2 He Helium 4.0026
3 Li Lithium 6.939	4 Be Beryllium 9.0122											5 B Boron 10.811	6 C Carbon 12.01115	7 N Nitrogen 14.0067	8 O Oxygen 15.9994	9 F Fluorine 18.9984	10 Ne Neon 20.183
11 Na Sodium 22.9898	12 Mg Magnesium 24.312											13 Al Aluminum 26.9815	14 Si Silicon 28.0855	15 P Phosphorus 30.9738	16 S Sulfur 32.064	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.0983	20 Ca Calcium 40.08	21 Sc Scandium 44.956	22 Ti Titanium 47.90	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.847	27 Co Cobalt 58.9332	28 Ni Nickel 58.71	29 Cu Copper 63.54	30 Zn Zinc 65.37	31 Ga Gallium 69.72	32 Ge Germanium 72.59	33 As Arsenic 74.9216	34 Se Selenium 78.96	35 Br Bromine 79.909	36 Kr Krypton 83.80
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.905	40 Zr Zirconium 91.22	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium (97)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.905	46 Pd Palladium 106.4	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.69	51 Sb Antimony 121.75	52 Te Tellurium 127.60	53 I Iodine 126.9044	54 Xe Xenon 131.30
55 Cs Cesium 132.905	56 Ba Barium 137.33		72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.09	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.37	82 Pb Lead 207.19	83 Bi Bismuth 208.98	84 Po Polonium (210)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)		104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (262)	108 Os Hassium (265)	109 Mt Meitnerium (266)									
		57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.907	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.35	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.924	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.97	
		89 Ac Actinium (227)	90 Th Thorium 232.038	91 Pa Protactinium (231)	92 U Uranium 238.03	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (254)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (255)	103 Lr Lawrencium (256)	

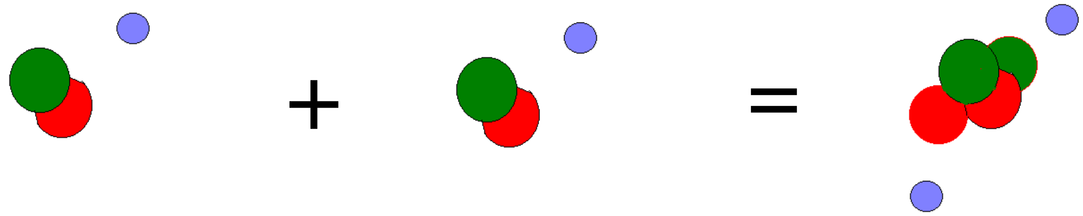
Atoms, Elements and Mass

The average atomic masses included in the Periodic Table of the Elements do not match the masses given for specific atomic isotopes listed in the table on page 14. The mathematics of mass-to-energy conversion is not easily followed with a table of average atomic weights. A precise measurement of mass is needed for each atomic isotope.

Sunshine, Bombs, Mass, and Energy

The nuclear reactions of deuterium atoms can convert small amounts of mass into large amounts of energy. Deuterium is a special fuel used in two of the nuclear fusion reactions our sun uses to produce our morning sunshine. Deuterium is a necessary intermediate product in the proton chain method.[5] (Proton + proton = deuterium; deuterium + proton = helium 3; and helium 3 + helium 3 = helium 4 + 2 protons.) Deuterium is also used directly in nuclear fusion to make helium. Two deuterium atoms can unite to make one helium atom, as illustrated by the equations below:

Deuterium + Deuterium = Helium 4



2.0140 AMU + 2.0140 AMU > 4.0026 AMU

Deuterium has an atomic mass of 2.0140 AMU (atomic mass unit). Two times 2.0140 AMU equals 4.0280 AMU, but one helium 4 atom weighs only 4.0026 AMU. Surprise! Two deuterium atoms weigh more than one helium 4 atom! (See the table on page 14.) Where is the other 0.0254 AMU? This tiny bit of mass is converted to energy according to Einstein's famous equation, $E = MC^2$. The fantastic power of nuclear energy may be illustrated with the aid of an aspirin. One 500 milligram aspirin converted to energy would provide enough power to blow 3 million tons of rock one mile high! This is why one hydrogen bomb may be used to destroy an entire city and how our sun can shine so brightly for thousands of years without fading. Our sun[6] converts about 4 million tons of mass to energy each second and generates enough heat and light to supply 500 million planets the size of Earth!

Sunshine

No deuterium, no sunshine!

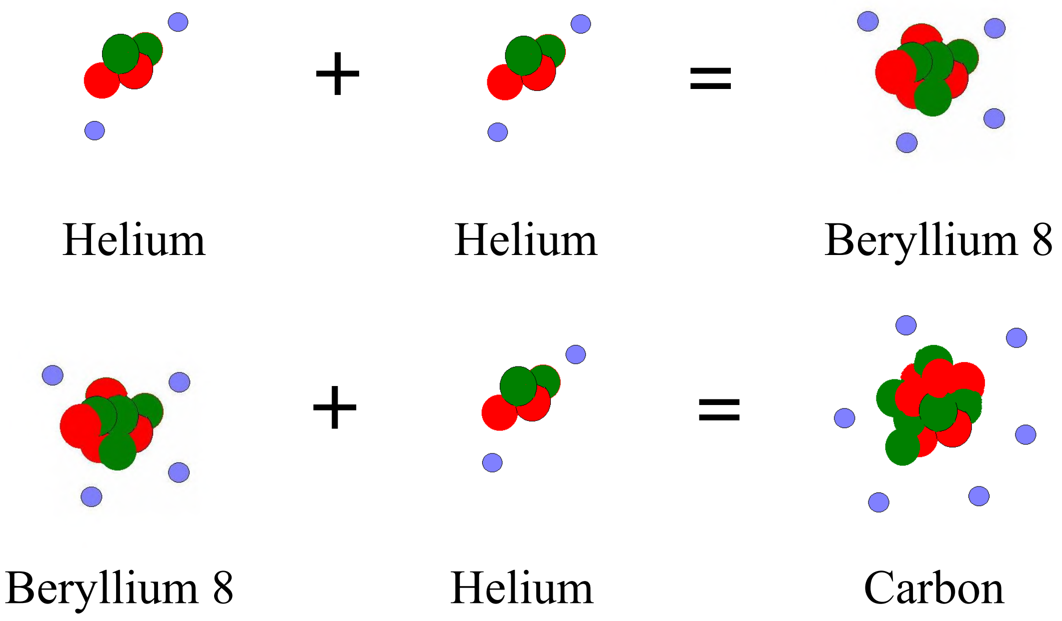
Large Atoms

Larger atoms like uranium and gold are made and blasted into space by supernova events[7] in the death of stars. Some representatives of all ninety-two naturally occurring elements have landed here on Earth. Hydrogen is the smallest type of atom and it has the smallest mass. Hydrogen atoms were broadly scattered at the birth of the universe and are still found in every part of outer space. All other atoms are bigger and more complicated. Larger atoms like oxygen and iron are virtually all made in the huge nuclear furnaces we call stars. The materials used in the formation of planets, moons, asteroids, meteors, dust, and comets are produced by nuclear reactions in stars and distributed by supernovas. Even the space dust that allowed the astronauts to leave footprints on the moon is part of the remains of supernova explosions. Only supernovas are known to produce the atoms that were needed to form the planet Earth.

Stars Make Atoms

Most of the atoms bigger than hydrogen and helium are made by stars. The details are most fascinating. Stars are formed when large clouds of hydrogen, helium, and other atoms are compressed by gravity. The process of compression heats the gases, and when the temperature[8] reaches about 15,000,000 K, hydrogen atoms are bonded by nuclear fusion to make helium. (K stands for degrees Kelvin. Water boils at 373 K.) Nuclear fusion generates large amount of heat and light, and in this way a large, dark cloud of gas becomes a bright and shining star.

Our sun burns 600 million metric tons of hydrogen each second to make helium and produces 400 trillion trillion watts of energy.[9] When a star begins to run out of hydrogen it begins to cool and contract. As the star contracts the force of gravity increases, the helium atoms are forced closer together and the temperature rises tremendously. If the star reaches about 100,000,000 K another remarkable thing begins to happen.[10] The helium atoms combine with each other to form carbon atoms. This is a two-step process, as shown below:



The process of building carbon atoms generates large amounts of heat and light. The star expands and is reborn. Eventually the star consumes its helium and begins to cool and contract again. If a star is big and has strong gravity, the compressed gases of the dying star will reach 600,000,000 K. At this point the carbon atoms are burned to make larger atoms such as oxygen, magnesium, neon, and silicon. This is the third round of fireworks. Eventually the fusion reactions begin to make iron, and iron is the beginning of the end for some of the stars bigger than our sun.

In the spiral shaped galaxy on the right, some stars are burning hydrogen, some are burning helium and some are burning carbon.

Spiral Shaped Galaxy M101

Iron Is Crushed

Iron has the most tightly bound nucleus of any element.[11] It has the atomic number 26, and it is the last stop for the energy generators. Stars cannot use iron in nuclear reactions to produce energy. Energy must be added in fission processes that break iron into smaller atoms, and energy must also be added in fusion processes that add mass to iron to make atoms larger than iron. Iron is useless as nuclear fuel for stars. Heavy, unburnable iron accumulates at the center of the star. As more and more of the star is converted into iron, the pressure on the iron core increases. If the star is big enough the iron atoms are eventually crushed under the weight of the star, similar to the collapse of the World Trade Center. As each iron atom is crushed, the remains are just more weight to crush the rest of the iron atoms. The enormous pressure is high enough to force the electrons to bond with the protons in the iron atoms to make neutrons. The newly formed neutrons occupy only a tiny fraction of the volume once occupied by the doomed iron atoms.

The iron core of a star may be ten miles or more in diameter. The core can implode and be reduced to neutrons in a few minutes. The imploding core produces a monster shock wave that triggers massive nuclear reactions, and the star explodes. In this explosion, called a supernova, many atoms are formed. The star may be destroyed and blown to bits. The supernova event produces fabulous amounts of energy and light. One star in the supernova state may produce more energy and light than one hundred billion stars as bright as our sun!

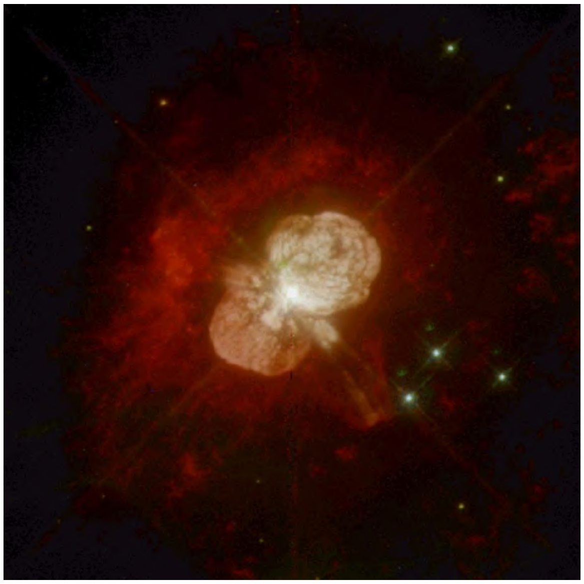
In the death of large stars, the seeds of planets are sown. Only supernovas produce and distribute the building blocks of moons and planets. Without supernovas like the Crab Nebula, N 63 A, and Eta Carinae there could be no building blocks for life on our own planet Earth.

Supernova N 63 A

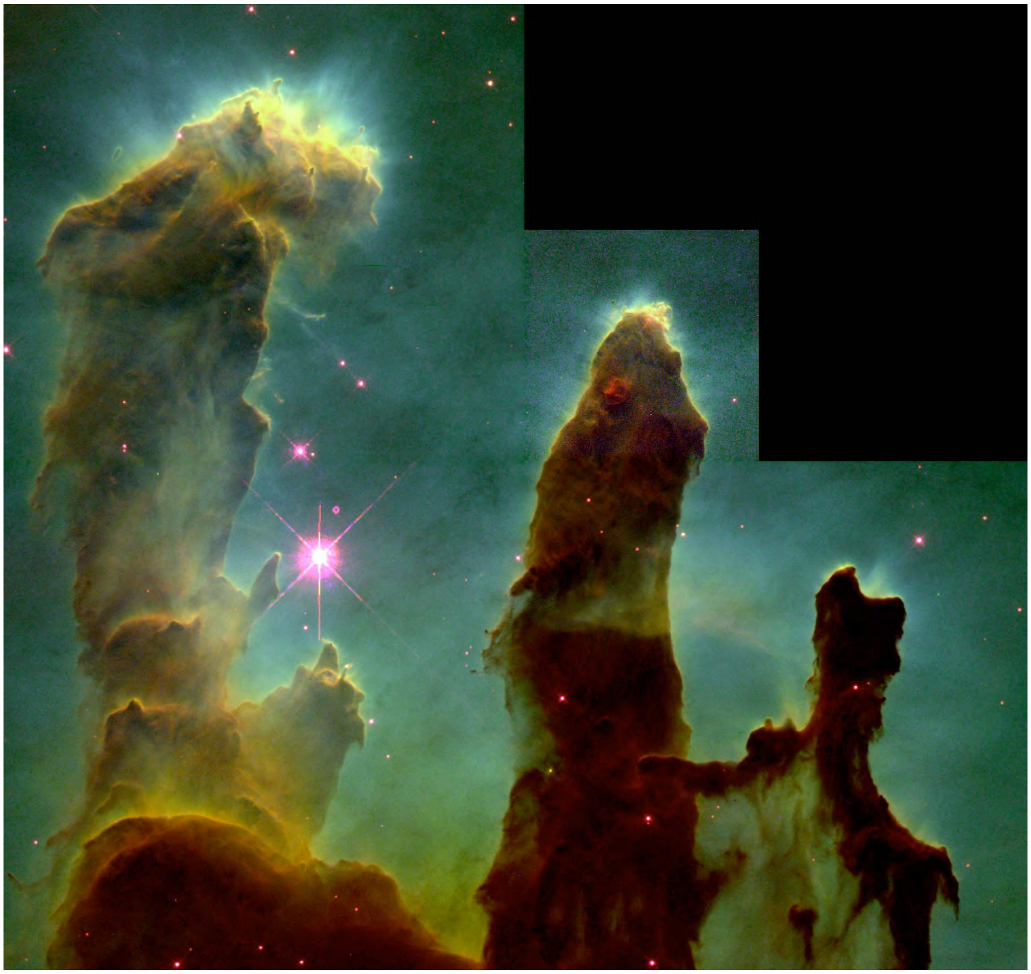
The Hubble image above of supernova N 63A is a color representation of data taken in 1997 and 2000 with Hubble's wide field planetary camera 2. Color filters were used to sample light emitted by sulfur (shown in red), oxygen (shown in blue), and hydrogen (shown in green).

Eta Carinae is a famous and spectacular supernova[12] that is shown in the Hubble image on the right.

Our universe contains a lot of dust, clouds, and explosion debris as shown in the picture of the Eagle Nebula below.



Eta Carinae



Eagle Nebula

The Distribution of Atoms

Atoms like carbon, nitrogen, and oxygen are made and dispersed by stars. Oxygen is the most abundant element on the surface of the Earth. The Earth's crust is 46.6 percent oxygen by weight. Common sand is about 50 percent oxygen by weight. The primary components of the Earth's crust have atomic numbers less than or equal to iron. Elements heavier than iron are scarce in the universe because energy must be added to the nuclear reactions that add mass to iron atoms. The composition of the Earth's crust and the composition of the Earth's atmosphere are summarized in the two tables below:

Composition of the Earth's Crust[13]

Atomic Number (Number of Protons in Nucleus)	Element	Percent by Weight
8	Oxygen	46.6
14	Silicon	27.7
13	Aluminum	8.1
26	Iron	5.0
20	Calcium	3.6
11	Sodium	2.8
19	Potassium	2.6
12	Magnesium	2.0
6	Carbon	0.03[14]
	Sum	98.43

As you may easily see, none of these elements have atomic numbers greater than iron. The remaining 1.57% of the Earth's crust is composed of the other 83 naturally occurring elements.

Composition of the Earth's Permanent Atmospheric Gases[15]

Only the five most significant elements are included in this table.
Chemical compounds like water and carbon dioxide are not included.

Atomic Number (Number of Protons in Nucleus)	Element	Percent by Volume
7	Nitrogen	78.084
8	Oxygen	20.948
18	Argon	0.934
10	Neon	0.001818
2	Helium	0.000524

None of the atoms in the table above have atomic numbers greater than iron.
Carbon dioxide is at about 0.038% (380 parts per million) and rising[16].

The ninety-two naturally occurring elements on Earth are constructed with great energy and precision. All of the neutrons have the same mass. All of the protons have the same mass. All of the electrons have the same mass and the same identical charge[17] of 1.602189×10^{-19} coulomb. Neutrons, electrons, and protons, are bonded together to form all of the atoms in our universe. Atoms of the same isotope are identical in every way that scientists can measure. Because atomic parts are mass produced and identical, the interchangeable parts allow atoms to be bonded together to construct uniform molecules. Notice in the table below that the first five elements listed are found in higher concentrations than the other atoms in the universe. All of the other atoms combined make up a very small fraction of the universe.

Distribution of Atoms in the Universe[18]

Common Elements Important in Living Organisms

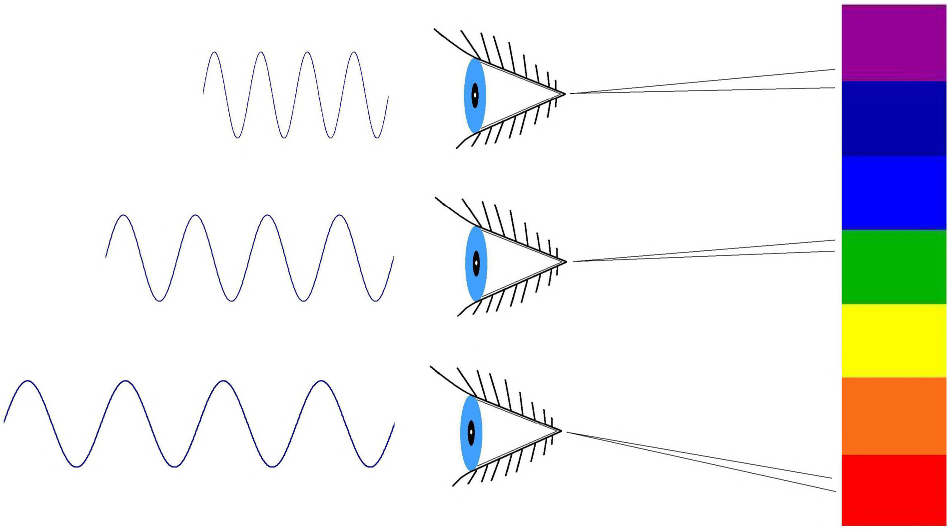
Element	Atomic Number	Percent in Universe[a]	Percent in Earth[a]	Percent in Human Body[a]
Hydrogen	1	91	0.14	9.5
Helium	2	9	Trace	Trace
Carbon	6	0.02	0.03	18.5
Nitrogen	7	0.04	Trace	3.3
Oxygen	8	0.06	47	65
Sodium	11	Trace	2.8	0.2
Magnesium	12	Trace	2.1	0.1
Phosphorus	15	Trace	0.07	1
Sulfur	16	Trace	0.03	0.3
Chlorine	17	Trace	0.01	0.2
Potassium	19	Trace	2.6	0.4
Calcium	20	Trace	3.6	1.5
Iron	26	Trace	5	Trace

[a] Approximate percentage of atoms of this element, by weight, in the universe, in the Earth’s crust and in the human body.

Stars Make Light and Release Energy

Light is just the visible portion of the electromagnetic spectrum that is blasted into space by stars, and only a very small fraction of the electromagnetic spectrum is visible to the human eye. Most of the visible light has wavelengths between 400 and 700 nanometers.[19] A large part of the nonvisible portion is absorbed by air and water.

Human eyes interpret different wavelengths of light as different colors. This is illustrated in the diagram on the right.



Different colors of light have different wavelengths

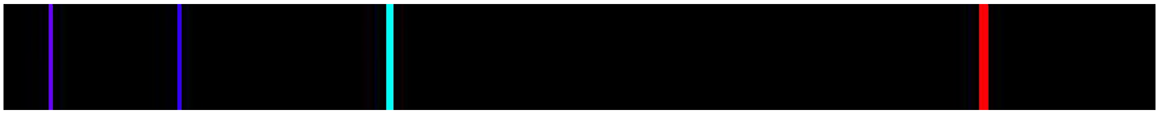
The different wavelengths of light allow us to see a world of color, such as the pretty flowers in the picture below.

Pretty Flowers

Precise Light

Light is very precise. When I graduated from high school in 1972 a length of one meter was defined as 1,650,763.73 wavelengths of light[20] in a vacuum of the unperturbed transition from energy level 2P10 to energy level 5D5 in krypton 86. Now one meter is defined[21] as the distance traveled by light in one second divided by 299,792,458. Hence light travels 299,792,458 meters in one second. All electromagnetic radiation—X-rays, radio waves, and all the different colors of light—travel at exactly the same speed. All atoms of the same composition emit light at the same frequencies and wavelengths. The set of light waves emitted by a particular type of atom may be used like a set of fingerprints to determine the identity of atoms. Scientists use this method called spectroscopy to determine the composition of the sun.

When hydrogen gas is heated it gives off light. A prism may be used to separate the different wavelengths of hydrogen light. Four examples of visible light given off by hydrogen gas are illustrated in the figure below:



Visible Emission Spectrum of Hydrogen

All hydrogen atoms of the same isotope give off the same wavelengths of light. The wavelengths of the four visible bands of hydrogen light shown in the figure above may be calculated using an equation discovered by Johann Balmer[22] in 1885:

$$\text{Wavelength} = 364.6 \text{ x } \left(\frac{m^2}{m^2 - n^2} \right)$$

where the wavelength of the light is given in nanometers and *m* and *n* are simple counting numbers like 2, 3, 4, 5, and 6. Wavelengths calculated by using the Balmer equation are compared to measured wavelengths[23] in the table below:

Wavelengths of Light Given Off by Hydrogen

Color	Wavelength in Nanometers		m	n
	Measured	Calculated		
Red	656.3	656.280	3	2
Blue Green	486.1330	486.133	4	2
Blue	434.0470	434.048	5	2
Violet	410.1740	410.175	6	2

This table shows that light is precise. It is not an accident.