

The Unified Theory of Stellar Evolution

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Introduction

Massive stars are continually being created in our spiral arm galaxy. Plasmas of energetic protons and electrons combine and form hydrogen, the lowest element on the periodic table. [In many cases, the plasmas of elementary particles were ejected during past supernova explosions.] A new star is formed as this super heated hydrogen accumulated into a great spherical ball. The process of fusion begins as the star gains sufficient mass. Two atoms of hydrogen are combined and transformed into an atom of helium releasing vast amount of fusion energy. O-type stars are very hot and luminous, and appear in the visible spectrum as bluish-white stars. These stars are commonly called giants, and supergiants. These stars have between 15 and 90 times the mass of our Sun and surface temperatures between 30,000 and 52,000° K. They are between 30,000 times and several million times as luminous as our Sun. The massive O- and B-type stars that occupy the spiral arms have relatively short life spans in the order of 3-30 million years depending on their size. As these stars exhaust their nuclear fuel, they self-destruct in a massive explosion called a supernova leaving behind a dead carcass called a black hole. The reason why these stellar remnants are referred to as black holes is because they are essentially invisible. In general, light and matter that enters a black hole never comes out again. After a black hole has formed, it can continue to grow by absorbing mass from its surroundings. By absorbing and merging with other stars, black holes can grow in size. Some black holes are so large that they anchor entire galaxies together with its massive gravitational force. Generally these supermassive black holes exist in the centers of most galaxies. For example, Sagittarius A, at the core of our own Milky Way galaxy, contains a supermassive black hole with an estimated mass equivalent to approximately 4.3 million times the mass of our sun.

Current Theory

A black hole is a region of spacetime exhibiting such strong gravitational effects that nothing—not even particles and electromagnetic radiation such as light—can escape from inside it. The theory of general relativity predicts that a sufficiently compact mass can deform spacetime to form a black hole. The defining feature of a black hole is the appearance of an event horizon—a boundary in spacetime through which matter and light can only pass inward towards the mass of the black hole. Nothing, not even light, can escape from inside the event horizon. At the center of a black hole, as described by general relativity, lies a gravitational singularity, a region where the spacetime curvature becomes infinite. The photon sphere is a spherical boundary of zero thickness in which photons that move on tangents to that sphere would be trapped in a circular orbit about the black hole. Rotating black holes are surrounded by a region of spacetime in which it is impossible to stand still, called the ergosphere. This is the result of a process known as frame-dragging; general relativity predicts that any rotating mass will tend to slightly "drag" along the spacetime immediately surrounding it.¹

Let's set all this current theory aside for a few seconds and look at a black hole from a different perspective -- let us say a more classical perspective. To begin, let us discuss as a foundation the next two topics: **The Void**, and **Light and the Atomic Structure**.

The Void

The first foundation stone in this theory is a discussion of the void, otherwise called empty space. A vacuum is space void of matter, containing nothingness.

We live in a solar system that has a star with considerable mass called the sun and 8 less massive planets that orbit around the star (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune). The outermost planet is Neptune, which is located approximately 4,500,000,000 kilometers from the sun. Let us define the volume of our solar system as a sphere encompassing the outermost planet. The volume of the combined matter (sun, planets and moons) accounts for a miniscule fraction of amount of the volume occupied by our solar system (approximately 0.000,000,000,004). The rest is essentially a void, a vacuum in space devoid of matter.

The structure of our solar system is similar to the structure of an atom. At the center is the nucleus comprised of heavy particles called protons and neutrons. Circling around the nucleus are lighter particles called electrons at various orbits or shells. Another important characteristics that both solar systems and atoms share is that most of the volume within an atom is empty space.

The main point is that matter occupies only a miniscule part of a solar system structure. And matter occupies only a miniscule part of an atomic structure. The predominant parts of these two types of structures are occupied by empty space.

A black hole is compressed matter. It is basically an atomic configuration where most of the space has been removed. The configuration is stable and held together by extreme gravitational forces.

Light and the Atomic Structure

Light is electromagnetic radiation. A photon is a quantum of light (or a single unit of light). The primary properties of light are intensity, propagation direction, frequency (or wavelength), and polarization, while its speed in a vacuum, 299,792,458 meters per second, is one of the fundamental constants of nature. Light covers a full spectrum of wavelengths including radio waves, microwaves, infrared light, visible light, ultraviolet light, x-rays and gamma rays. One of the key properties of light is the ability to interact with matter. This is a second foundation stone in this discussion.

Atoms can absorb and emit light. When an atom absorbs light, the electrons circling the nucleus move to a greater orbit or shell. In an excited state, atoms can also release that energy and the electrons will fall back to a lower shell or rest state. When this happens the energy release produces light at very distinct frequencies, which is a function of the particular type of atom that absorbed the light. Two applications easily come to mind: spectroscopy and lasers.

The whole field of spectroscopy is based on this process. Every atom has its own unique fingerprint of light signature. Thus by measuring the spectrum of frequencies of light emitted by an atom as it goes from an excited state to a rest state, the type of atom can be identified.

Another example of this interaction between light and atoms is observed in lasers. A laser is a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation. In a laser, energy is applied to a very pure medium, such as a

synthetic ruby crystal. This excites the atoms in the material moving the electrons to an outer shell. The medium is triggered which allows all the atoms at once to return to their lower state producing a beam of electromagnetic energy. This beam is composed of millions of photons with the same frequency and because they were triggered in an instant, the beam is very coherent. All the waves are aligned together which minimizes dispersion and allows the narrow beam to travel great distances (in a vacuum) without losing the intensity of the beam.

The main point is that the atomic structure can absorb and release light.

Supernova

Stars provide vast amounts of energy for millions of years through the process of nuclear fusion. Nuclear fusion occurs when two elements are fused together to form a heavier element. This process releases energy. Massive Type "O" stars begin as a giant ball of burning hydrogen. Over time the composition of the massive star is converted into helium. The nucleosynthesis, or fusion of lighter elements into heavier ones, continues to produce other elements moving up the periodic table until it reaches nickel [56]. This isotope undergoes radioactive decay into iron [56], which has one of the highest binding energies of all of the isotopes, and is the last element that produces a net release of energy by nuclear fusion, exothermically. All nuclear fusion reactions

that produce heavier elements cause the star to lose energy and are said to be endothermic reactions. The pressure that supports the star's outer layers drops sharply. As the outer envelope is no longer sufficiently supported by the radiation pressure, the star's gravity pulls its outer layers rapidly inward. As the star collapses, these outer layers collide with the incompressible stellar core, producing a shockwave that expands outward through the unfused material of the outer shell. The star explodes into a massive supernova dispersing the outer layers of material from the star into interstellar space.³ After this massive explosion the carcass of the massive dead star, a black hole, remains.

So what happens after this implosion? I would suggest that the process of nuclear consolidation continues. As a star generates energy through fusion, the number of atoms within the star decreases. The time required for each atomic structure realignment accelerates as the structure transitions towards heavier and heavier atoms. The composition of the star will be continually consolidated until it is finally restructured into a single complex atom. After a massive explosion called a supernova, the carcass of a massive dead star will finally reach an end state of a single massive atom; a compressed and compact structure containing very little free space.

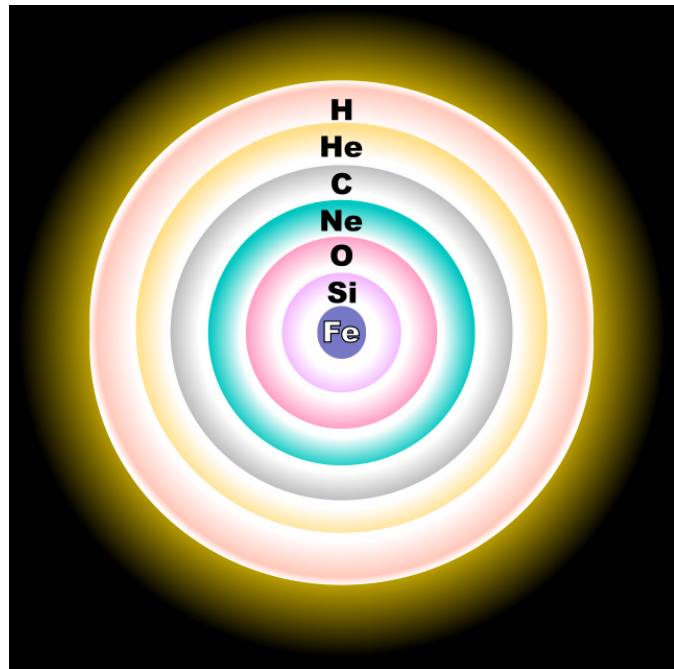


Figure 1 The onion-like layers within a massive star just before core collapse in a Supernova (Reference 2)

Even though gravity is a very weak force, the contraction of matter through atomic restructuring, can make it a major influence at the atomic level. I assert because of the crushing gravitational force and the large energy levels available within a sealed black hole, these rare atoms are not only created; but also sustained and stable.

A black hole is a massive atom comprised of untold billions of neutrons and protons surrounded by untold billions of electrons. The structure is very compact. A transition from a structure of many atoms to a structure of one massive atom reduces the size of a massive star to a smaller diameter black hole because most of the empty space has been removed by the restructuring. Such a structure is capable of producing extreme magnetic fields. The structure can also grow as it absorbs matter and energy from space.

During a supernova, a massive star transitions from an exothermic star to an endothermic star. An exothermic star releases energy (sunlight/starlight) through the process of nuclear fusion. An endothermic star absorbs energy. A black hole is the definition of an endothermic star. The nuclear fusion process does not end at iron [56] but continues ever onward. The transition from an exothermic star to an endothermic star is accomplished as the atomic structure within the star changes from multiple atoms to a single heavy atomic structure. In the endothermic state, the star absorbs energy, which allows the star to integrate additional components (neutrons, protons, electrons) into the structure producing heavier and heavier atoms. Some endothermic stars (black holes) are so massive that they exert so massive a gravitational force that they anchor entire galaxies together.

A massive single atom, which I will redefine as singularity, is capable of absorbing and storing vast amounts of energy as electrons are moved to the outer shells. This energy is available to continue the process of nuclear fusion by binding additional matter (elementary particles) into the structure.

After a supernova, a black hole becomes a closed system where the energy produced by fusion is retained by the star allowing the endothermic star to grow by absorbing other matter. A black hole can absorb matter from galactic cosmic rays (GCRs) [protons, ions, electrons], from small bodies [asteroids and comets], from planets, and from stars [exothermic stars, white dwarf star, neutron star and other black holes]. Over long periods of time, it can even swallow up and cannibalize entire solar systems and galaxies.

When a black hole encounters other massive objects such as stars, solar systems and black holes, it can initiate a feeding frenzy. The black hole will strip out some matter and energy and violently release the rest. A black hole can cannibalize and integrate additional matter and energy into its atomic structure. But the process can at times become messy. Sometimes this is caused by a release of kinetic energy. When the cannibalization process is out of balance, it can release a massive burst of energy such as gamma-ray burst (GRBs).

The electromagnetic spectrum is the collective term for all known frequencies and their linked wavelengths of light (photons, electromagnetic radiation). The electromagnetic spectrum extends from below the low frequencies used for modern radio communication to gamma radiation at the short-wavelength (high-frequency) end, thereby covering wavelengths from thousands of kilometers down to a fraction of the size of an atom. As black holes absorb light they cause electrons rotating around the black hole nucleus to move to outer shells. Sometimes this energy can be triggered and instantly release a short burst of intense electromagnetic radiation. As a result the electrons rotating around the nucleus of a black hole will fall back into a lower shell. This

released energy has coherent wavelengths and phased together which allows it to travel immense distances without being attenuated, similar to a focused laser beam.

Gamma-ray bursts are extremely energetic explosions that have been observed in distant galaxies. They are the brightest electromagnetic events known to occur in the universe. Gamma rays have the smallest wavelengths and the most energy of any other wave in the electromagnetic spectrum. These bursts can last from ten milliseconds to several hours. They are extremely energetic (a typical burst releases as much energy in a few seconds as the Sun will in its entire 10-billion-year lifetime) and are extremely rare events (a few per galaxy per million years).

A black hole is not an unknown. It is a known entity held together by the rules of atomic structure. A black hole is comprised of basic elementary particles (protons, neutrons, electrons) compressed into a singularity, a single massive heavy atom; a structure almost void of empty space.

Gravity & Light

Albert Einstein's general theory of relativity predicts that mass can bend light (electromagnetic energy). A gravitational lens is defined as a massive object between a distant light source and an observer, which is capable of bending the light from the source as the light travels towards the observer. In general relativity, light follows the curvature of spacetime, hence when light passes around a massive object, such as a black hole, it is bent. This means that the light from an object on the other side will be bent towards an observer's eye, just like an ordinary lens. Since light always moves at a constant speed, lensing changes the direction of the velocity of the light, but not the magnitude.⁴

In the field of particle physics, four forces exist. These forces are the strong nuclear force, the electromagnetic force, the weak nuclear force and the gravitational force. The strong force is responsible for binding the nuclei. The electromagnetic force exists between particles with an electric charge. The weak nuclear force is responsible for nuclear beta decay and plays an essential role in nuclear fusion.

Gravity is a force, which pulls two objects toward each other. Anything that has mass also has a gravitational pull. The more massive an object is, the stronger its gravitational pull. The closer two objects are together, the stronger its gravitational pull. Gravity is the weakest of the four fundamental interactions of nature. The gravitational attraction is approximately 10^{38} times weaker than the strong force, 10^{36} times weaker than the electromagnetic force and 10^{29} times weaker than the weak force. Although gravity is a weak force it can be amplified by mass compression.

Much of the current theory about black holes is based on the premise that light can be bent by very strong gravitational forces. I do not subscribe to this component of the theory. A photon is a quantum of electromagnetic radiation. A photon carries energy proportional to the radiation frequency but has zero rest mass. If an object has zero mass, then a photon should not be affected by gravity.

Did you ever wonder how light is reflected off the surface of a mirror? Or how a glass prism separates white light into many colors (different frequencies)? Or how small droplets of water produce the colors of a rainbow after a great storm? Or how the sun appears as a yellow ball of

light at sunset or sunrise, when in fact it is really below the horizon? I am not speaking at the molecular level, which is the branch of physics called optics, but rather I am speaking about what takes place at the atomic level, the interaction of individual photons and individual atoms. These phenomena are not caused by gravitational forces bending light. These phenomena are caused by the ability of matter to absorb and emit photons at the atomic level.

So it might appear that the great mass of a black hole is bending light, but that is just an illusion. The atomic structure can absorb and release light. Light is absorbed by the massive flow of electrons that surround the core of the black hole. This absorption excites electrons into outer shells, slightly greater orbits. That is why black holes appear to be invisible. Phenomena, such as gravitational lensing, occur when some of the electrons return to less energetic states and release light. Other phenomena, such as gamma ray burst, occur when an instability occurs within a black hole producing a massive release of energy as layers of electrons return from excited states to their rest state.

Gravity Switch

A black hole can grow through accretion by fusing matter and energy into its single atomic structure. But this process is not infinite. Eventually the structure will reach a point where the gravitational forces break up the building blocks of elementary particles (neutrons, protons, electrons) into their fundamental subcomponents (quarks).

In the end after eons and eons of time, after infinite numbers of super massive black holes merge together, the gravitational forces and energy levels within will cause even the elementary particles, such as protons to break apart into quarks and quark-gluon plasma. And the whole structure will unravel because as one converts matter into pure energy, the force gravity produces will no longer hold sway because of a dramatic reduction in the systems mass. And the end stage of a super massive black hole is a big bang.

The Big Bang theory describes the universe as having formed from a tremendous explosion. The matter and energy released from this explosion evolved into the present stars and galaxies. Edwin Hubble provided the foundation for the Big Bang theory by showing that the universe is expanding from a common origin.

In order to understand the structure of the universe, it is important to understand the evolutionary cycle of a black hole.

A black hole forms at the end of the life of a very massive star. When a large star has burnt all its fuel, it explodes into a supernova. The star transforms from an exothermic star to an endothermic star, or black hole. The condensation of matter amplifies the effects of gravity at the atomic level. It provides stability to a single massive atomic structure. This structure minimizes the void. Over time, this singularity can grow as it absorbs additional matter and energy into its atomic structure. A black hole can become very large with the mass of million or more suns. These can be found at the center of galaxies.

In 1964, Murray Gell-Mann and George Zweig proposed that nuclear particles are composed of smaller fundamental particles called quarks. A neutron is composed of one "Up" quark and two "Down" quarks. A proton is composed of two "Up" quarks and one "Down" quark. The transfer

medium within protons and neutrons is a strong interactive force carrier called gluons. Nuclear particles can break down into quark-gluon plasma (QGP) under extreme temperatures and pressures.

Splitting the atom (restructuring the atoms via fission/fusion) can release a vast surge of energy. The atomic bomb is a typical example of the energy released from this transformation. But the force that holds atoms together is very weak in comparison to the force that binds quarks into stable nuclear particles.

As a black hole evolves, it continues to absorb matter and energy. It grows until it reaches a critical limit where the pressure and temperature cause the nuclear particles to break down into quarks. The breakdown of the neutrons and protons in the nucleus of a black hole produces several effects. The breakdown turns off the gravity switch. Gravity is a function of mass. The mass of a proton is 938 MeV whereas after the breakdown, the total mass of the triplet of quarks that remain is approximately 20 MeV. What happens to the missing mass? It is converted into a tremendous quantity of energy. This energy sets off a cascading chain reaction that produces quark-gluon plasma. This plasma in effect rips the end stage black hole apart and produces what is referred to as the Big Bang.

References

- 1 Wikipedia, Black Hole, URL https://en.wikipedia.org/wiki/Black_hole [cited 16 March 2017].
- 2 Wikipedia, Stellar evolution, URL https://en.wikipedia.org/wiki/Stellar_evolution [cited 20 March 2017].
- 3 Wikipedia, Supernova nucleosynthesis, URL: https://en.wikipedia.org/wiki/Supernova_nucleosynthesis [cited 10 March 2017].
- 4 Wikipedia, Gravitational lens, URL https://en.wikipedia.org/wiki/Gravitational_lens [cited 23 March 2017].