SUPERNOVA! Suggested Script	
PRESENTATION NOTES **This presentation can take from 20 minutes up to 60 minutes, depending on how many *Optional Presentation Activities* are included.** **Recommended for 7th grade to adult. (Use more activities with younger audiences)** There are two PowerPoint files: The one formatted for a PC (Microsoft) is "***SupernovaPC.ppt***." This version needs **Windows Media Player** to play the movie in slide 11. The one formatted for a Mac (Apple) is "***SupernovaMAC.ppt***." This version needs **QuickTime Player** to play the movie in slide 11.	
1.	Who has heard of a supernova? <CLICK> What is a supernova? <CLICK> Are they dangerous to life on Earth? <CLICK> How would the universe be different if supernovae never occurred? We'll explore these and other questions in this presentation. ---- *Image is an artist's conception.*
2.	A hundred years ago, we believed we lived in a quiet, safe universe. Without telescopes placed above Earth's protecting atmosphere we had little evidence of cosmic radiation. ---- *Image Credit: University Lowbrow Astronomers. Ann Arbor, Michigan*
3.	Since the era of space telescopes, we know the universe is filled with powerful radiation: • Gamma-rays • X-Rays • Fast-moving atomic particles, called "cosmic rays" This radiation is not the kind of radiation we can detect with our eyes. Where does it come from? One source is black holes in the centers of galaxies. ---- *Image is an artist's conception of a black hole.*
4.	Another is the powerful magnetic fields around neutron stars. ---- *Image is an artist's conception of magnetic fields around a neutron star.*

5.	More commonly, the radiation originates from a supernova – the powerful explosion marking the end of a massive star's life. One type of supernova, the one we're mostly discussing in this presentation, is the explosion caused when a massive star dies and collapses. Only stars that contain more than 8 to 10 times the mass of our Sun will go supernova. During the explosion, the star will blow off most of its mass. The remaining core will form a neutron star or a black hole. ---- *Image Credit: NASA, ESA, J. Hester, A. Loll (ASU) Acknowledgement: Davide De Martin (Skyfactory) Crab Nebula Mosaic from HST* *The image of the Crab nebula is a supernova remnant and not a supernova. You may want to clarify this so the audience understands the difference between the actual supernova event and the evidence of past supernovae visible as remnants.* *Additional information:* Another basic type of supernova happens when a white dwarf pulls too much material off a companion star and then explodes. This is called a "Type 1a" supernova. For more information on different types of supernovae: http://imagine.gsfc.nasa.gov/docs/science/know_l1/sn_overview.html
6.	Where does the radiation come from? Stars are powered by fusing lighter elements into heavier elements in the cores of stars. <CLICK> Energy is released from fusion reactions and material at extremely high temperatures in the form of **gamma-rays**. <CLICK> **Atomic particles** like atomic nuclei are blasted away at high speeds from the shock wave of the supernova explosion. <CLICK> **X-rays** are generated once the shock wave from the supernova explosion slams into the blown-off outer layers of the star. What kind of stars will go supernova? ----- ***Optional Presentation activity:*** You might want to do the Nuclear Fusion activity from the ToolKit activity "Nuclear Fusion, Supernovae, and Cosmic Radiation" ---- *Image is an artist's conception.*
7.	Well, let's start talking about the lives of stars by looking at something we might be a little more familiar with – the life of a butterfly. <CLICK>A butterfly's lifecycle starts as an egg, <CLICK> then it becomes a caterpillar, <CLICK> then a pupa, <CLICK> then a full-grown butterfly. The grown butterfly lays eggs and soon new butterflies are born. A butterfly's appearance changes at each stage in its life. Changes that cause it to look nothing like it did at an earlier stage. ---- *Image is an artist's conception.*

8.	Stars also go through stages in their lives. Stages that cause the star to change its appearance as it progresses through each stage in its lifecycle. Stars of different masses progress at different rates and have quite different fates. ---- *Image is an artist's conception.*
9.	Let's walk through the life of a star like our Sun and then the life of a hot massive star. <CLICK> Stars of all sizes can be born as ***Protostars*** from a cloud of gas and dust in our galaxy (**a *Star-Forming Nebula***). When the protostar compresses under the force of gravity and its core becomes hot enough, the star begins fusing hydrogen in its core. <CLICK> **Sun-like Star:** For many billions of years a star like our Sun remains stable, fusing hydrogen in its core. <CLICK> **Red Giant:** After several billion years, the star uses up the hydrogen in its core, and it turns into a red giant. <CLICK> **Planetary Nebula:** At this point the star goes through an unsettled stage where it starts losing its outer atmosphere in what's called a planetary nebula which forms around the star. The cycle is shown here to continue from the planetary nebula back into the cloud of gas and dust. This represents the recycling of the elements created in the star back into the interstellar medium (back into the gas and dust between the stars in the galaxy) to provide material to make new stars. <CLICK> **White Dwarf:** The remaining core of the star cools down and shrinks to a white dwarf. After billions of years, the white dwarf cools off so much that it no longer glows and becomes cold and dark. ----- **Presentation Tip:** You may want to explain that planets don't form from the planetary nebula, in spite of the name. The name is left over from a time when astronomers did not know what these nebulae actually were, hypothesizing that they were planets because many looked like simple disks in small telescopes. ---- *Image is an artist's conception.*

10.	**Stages in the life of a massive star** <CLICK>**Massive Star:** For only <u>millions</u> of years, a star more than 8 to 10 times the mass of our Sun will remain stable, fusing hydrogen in its core. <CLICK>**Red Supergiant:** After several million years, the star uses up the hydrogen in its core and it turns into a red supergiant. The star continues to fuse atoms in its core into heavier and heavier elements until the core starts filling up with iron. Because the fusion process stops at iron, the core collapses under its own weight, no longer held up by the heat generated during fusion. <CLICK>**Supernova:** An explosive shock wave and the energy generated from the core collapse starts moving outward, heating the surrounding layers of the star, and BOOM. Most of the star is blasted into space in a supernova explosion. The cycle is shown here to continue from the supernova back into the cloud of gas and dust. This represents the recycling of the heavy elements created in the star and during the supernova explosion back into the galaxy to provide the material to make new stars — and planets. <CLICK> **Neutron Star:** Anything remaining of the star after the explosion turns into a neutron star or… <CLICK>**Black Hole**: … if the remains of the star are more than three times the mass of the Sun, it turns into a black hole. So only really massive stars will explode as a supernova. ----- ***Optional Presentation Activity:*** You might want to use the tennis balls and ping-pong balls to simulate a supernova explosion from the ToolKit activity “Let’s Make a Supernova” ---- *Image is an artist’s conception.*

11.	Let's travel to the core of a red supergiant … <CLICK> … which is about to go supernova. *[This is a 40-second video]* Here we go diving into the outer atmosphere of the star, getting closer and closer to the core. *[When you see the orange ball pop out from the center, you've reached the core of the star – about 12 seconds into the movie]* There it is! - where the star continues to fuse atoms into heavier and heavier elements until the core starts filling up with iron. Because the fusion process stops at iron, the core collapses under its own weight, then BOOM! *[about 28 seconds into the movie, the star explodes]* An explosive shock wave and the energy generated from the core collapse moves rapidly outward, and most of the star is blasted into space in a supernova explosion, along with large amounts of high-energy radiation. ---- For more information on this video: http://www.nasa.gov/vision/universe/watchtheskies/swift_multimedia.html This video is also available separately on the Manual and Resources CD in the PowerPoint folder. **Refer to the PPT_README** file in that folder for technical issues. ---- *Video is an artist's conception.*
12.	Now let's look at a special effect of some stellar explosions . . .
13.	The gamma-ray burst. A **G**amma-**R**ay **B**urst (GRB) is a short burst of very high-energy radiation from space. Lasting less than a second to a few minutes. One source of GRBs may be the explosion of a very massive star where most of the gamma-ray energy released in the explosion is focused into narrow beams, with one of the beams pointed in the direction of Earth. ---- *Image Credit: NASA; Image is an artist's conception.* For more information: http://www.nasa.gov/vision/universe/starsgalaxies/gammaray_extinction.html GRBs are detected approximately once per day and are brief, but intense, flashes of gamma radiation. They come from all different directions of the sky and last from a few milliseconds to a few hundred seconds. ----- ***Optional Presentation Activity:*** You might want to use the GRB lamp model to demonstrate the power of beamed radiation from the ToolKit activity "Gamma-Ray Bursts and Supernovae"
14.	All this radiation coming at us from space might seem dangerous – and if we are too close to it, it is dangerous! How close would a supernova or the source of a gamma-ray burst have to be in order to damage life on Earth? ---- *Image is an artist's conception.*

15.	Here on Earth we know that radioactive sources, like uranium, emit gamma-rays. If we get too close for too long, the exposure to radiation can harm us. So how far away do we need to be?
16.	Here's an illustration of the Milky Way galaxy and the location of our Solar System in it. Let's zoom in closer… ---- *Image is an artist's conception.*
17.	… to find out how close a supernova explosion would have to be …
18.	… in order for the radiation from that supernova explosion to endanger life on Earth.
19.	OK. Now we've zoomed in enough. A supernova would have to occur within 30 light years of us for the radiation to affect life. That 30-light-year distance is represented by the little white circle around the location of our Solar System. The nearest star likely to go supernova is over 250 light years away. So are we safe for now? Sure.
20.	We found out that gamma-ray bursts are more powerful than supernovae, though. So let's zoom out again and see how close a gamma-ray burst source would have to be to harm us.
21.	Here's the danger region for the source of a gamma-ray burst. <CLICK> It would have to occur within 8,000 light years – within our galaxy and quite close to us.
22.	Our galaxy is about 100,000 light years across. The nearest detected source of a GRB is over a billion light years away – far outside our galaxy. No danger from GRB sources yet either.
23.	In any case, there are still some amounts of radiation coming from space all the time. How has life on Earth been protected from this constant barrage of cosmic radiation? Strange as it may seem, Earth's atmosphere and magnetic field shield us from most of this high-energy radiation. The atoms in our atmosphere absorb gamma-ray and x-ray radiation protecting us from that kind of radiation. Earth's magnetic field deflects or captures a lot of the fast-moving atomic particles. <CLICK> But this also prevents us from detecting this radiation here on Earth's surface. So how does NASA study this radiation? ----- ***Optional Presentation Activity*:** You might want to use the Styrofoam sheet demonstration to show how Earth's atmosphere and magnetic field protect Earth. The ToolKit activity is "Protecting Earth from Cosmic Radiation."

24.	NASA has a number of telescopes out in space, above the atmosphere, to detect and study this radiation. Here are some of them. <CLICK> XMM-Newton, a joint mission with Europe, and Suzaku, a joint mission with Japan, are studying x-ray radiation. <CLICK> Swift and GLAST are primarily gamma-ray missions. --- For more details about these missions, see the section “More About the Missions” following this script. ---- *Images are artist’s drawings of the spacecraft.*
25.	Supernovae might seem dangerous. But if stars didn’t die in supernova explosions, if they just cooled off and collapsed, the universe would be very different. The supernova explosion releases a lot of the elements created in the star during its lifetime and also generates new heavier elements all in the matter of a few seconds. <CLICK> Like the oxygen in the air we breathe and in the water we drink. ----- ***Optional Presentation Activity*:** You might want to use the ToolKit activity “A Universe Without Supernovae.”
26.	Silicon in all our electronics. Hold up your cell phones! We would not have cell phones without supernovae.
27.	Gold for jewelry.
28.	Iron for steel, for blood cells and to build the Earth itself.
29.	Supernovae may seem dangerous, but a universe without supernovae would be a universe <CLICK> without life!
30.	Here’s Orion again. Which of its stars will eventually go supernova? <CLICK> It may look like a lot of the stars will go supernova. But we can only see the biggest and brightest of all the stars out there. Over 85% of the stars in our galaxy are small stars – stars like our Sun or smaller. But the stars are so far away that we can only see the brightest ones without a telescope. And the brightest stars also tend to be the most massive stars – the ones much more massive than our Sun. And it’s the most massive stars that will go supernova.
31.	*Optional endings:* • We can certainly appreciate how our lives are tied to processes in the rest of the universe through that spectacular event: the supernova. Thank you. ------- • So let’s go out and see some of the stars that will go supernova. ------ • Go to the <NEXT SLIDE> ----- ***Optional Presentation Activity*:** If an observing session follows your presentation, you might want to use the Supernova FAQs and star maps handouts from the ToolKit activity “Which Stars will go Supernova?” ---- *Photo courtesy of William Castleman*

32.	OPTIONAL ENDING:
	• At the beginning we mentioned some questions. Now who can tell me:
	  • <CLICK> What is a supernova? <audience responses>
	  • <CLICK> How dangerous are they to life on Earth? <audience responses>
	  • <CLICK> How would the universe be different if supernovae never occurred? <audience responses>
	You've been a great audience. Thank you!
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	Photo courtesy of William Castleman

More about the Missions

Swift (http://swift.gsfc.nasa.gov) is a first-of-its-kind multi-wavelength observatory dedicated to the study of gamma-ray burst (GRB) science. It was launched into a low-Earth orbit in November of 2004 and has detected hundreds of bursts.
For downloadable information and handouts related to the Swift Mission:
http://swift.sonoma.edu/resources/multimedia/pubs/
For downloadable animations on the Swift mission and GRBs:
http://swift.sonoma.edu/resources/multimedia/animations/index.html

The **Gamma-Ray Large Area Space Telescope** (GLAST: http://www.nasa.gov/glast) is an international and multi-agency mission studying the cosmos looking at objects that emit the highest energy wavelengths of light. Launched in 2008 into low-Earth orbit, its main mission objectives include studying active galaxies, supernovae, pulsars, and gamma-ray bursts.
For downloadable images, animations, and posters on the GLAST Mission:
http://glast.sonoma.edu/resources/

XMM-Newton (http://xmm.sonoma.edu/) is a joint NASA-European Space Agency (ESA) orbiting observatory, designed to observe high-energy x-rays emitted from exotic astronomical objects such as pulsars, black holes and active galaxies. It was launched in 1999 from the ESA base at Kourou, French Guiana. XMM" stands for X-ray Multi-Mirror.
For more information on the XMM-Newton Mission: http://xmm.esac.esa.int/

The **Suzaku** (http://suzaku-epo.gsfc.nasa.gov/) satellite provides scientists with information to study extremely energetic objects like neutron stars, active and merging galaxies, black holes, and supernovae in the x-ray energy range. Astronomers hope it will help answer several important questions: When and where are the chemical elements created? What happens when matter falls onto a black hole? How does nature heat gas to x-ray emitting temperatures? Suzaku was launched in July 2005 and is a collaboration between Japanese and US institutions including NASA.
For more information on the Suzaku Mission: http://www.nasa.gov/mission_pages/astro-e2/main/index.html