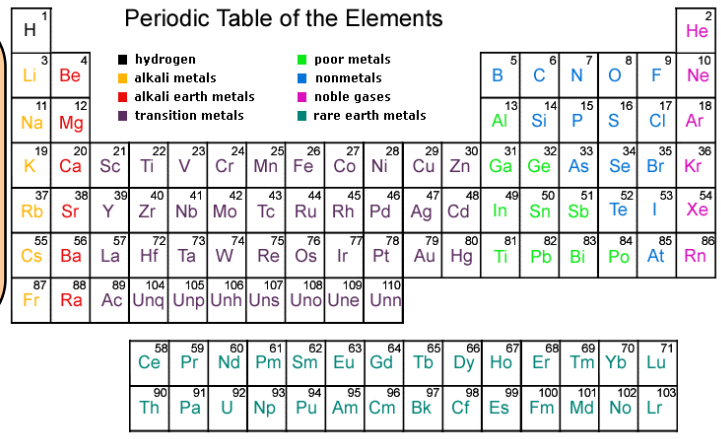
The Big Bang, Massive Stars, and Lavrion

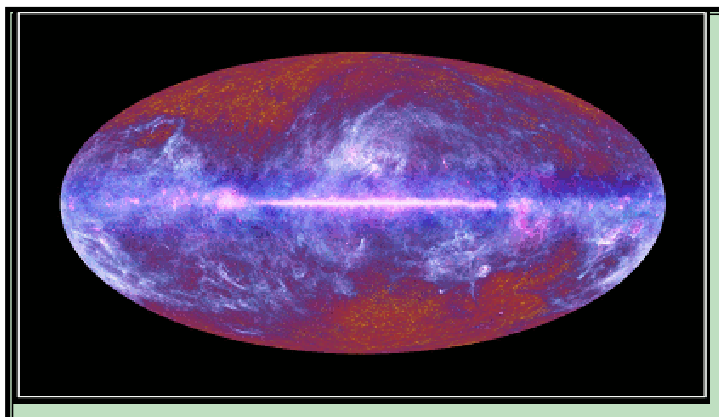
The cosmic origin of silver and lead

You and the elements:
The ancient Greeks believed that everything in the World is made of Fire, Air, Water, and Ether.

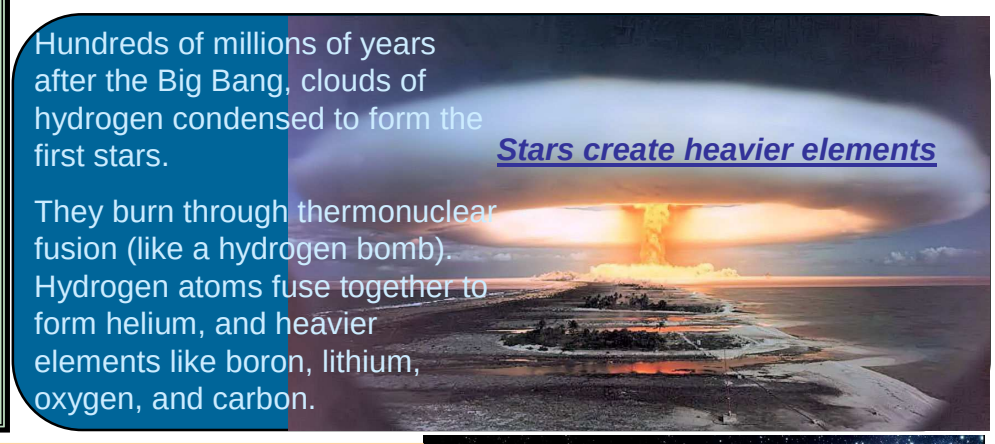
We now know that your body, your home, trees – everything! – is made of "atoms".
There are about one hundred different kinds. They combine to make molecules, and… everything!

Questions:
How and where were elements like hydrogen, carbon, sulfur, iron, potassium, gold, lead, & silver created?
How did the Lead and Silver in Lavrion's mines get there?





Big Bang – origin of the Universe
13.7 thousand million years ago, an "explosion" occurred. Protons and electrons formed, and combined later to make *hydrogen* (top-left of Table of Elements) as well as some *helium* (top-right of Table). This "photograph" of the whole sky is taken in microwave "light". The dim background is the radiation left over from the Big Bang, having cooled down with time to 3° above absolute zero.

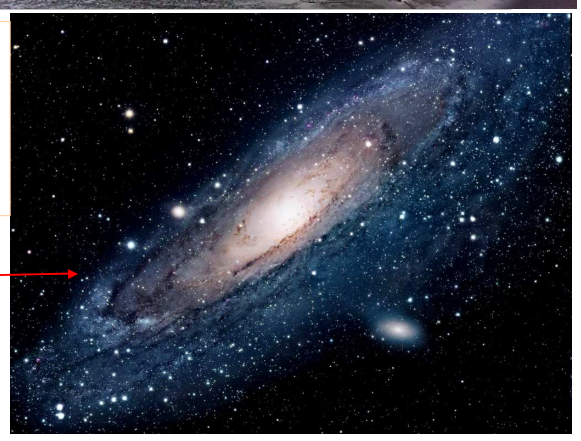


Hundreds of millions of years after the Big Bang, clouds of hydrogen condensed to form the first stars.

Stars create heavier elements

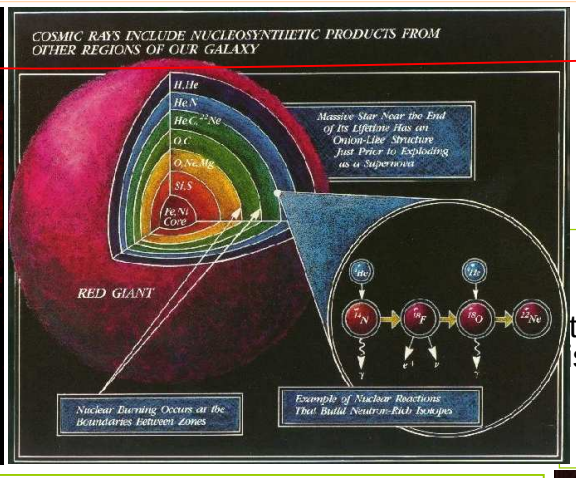
They burn through thermonuclear fusion (like a hydrogen bomb). Hydrogen atoms fuse together to form helium, and heavier elements like boron, lithium, oxygen, and carbon.

Stars group into *galaxies*, each with hundreds of millions of stars. Lavrion is in a Galaxy called the *Milky Way*. The photo at left is how it looks at night – we see the disk from the inside. The photo at right shows a nearby galaxy called *M31*, that looks like the Milky Way seen from outside.
The dark clouds and streaks are gas and star dust.



Our Sun -- a typical star.

Eta Carinae -- a heavy star with a strong stellar wind.



Massive stars create heavier elements

About 10% of stars are more than 5 times heavier than the Sun. Gravity there is stronger, and so the pressure is higher. More extreme thermonuclear reactions occur. All the elements up to Iron are created during the life of massive stars.

Massive stars burn hot and blow off a strong wind, full of heavy elements –*stardust*!

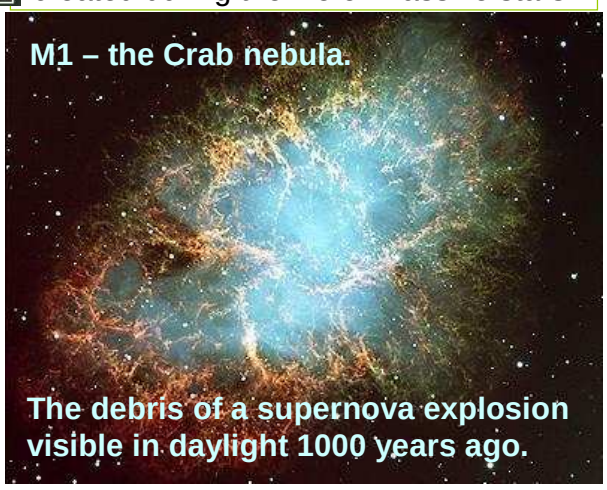
They burn fast, and don't live nearly as long as our Sun.

***Supernovae*!**

Massive stars burn fast until suddenly, all the fuel is gone. Gravity then makes the star implode. Pressure and temperature become so drastically high that thermonuclear detonation occurs. Two important things happen:

1. All the rest of the heavy elements in the Table of Elements are created, beyond Iron, to Lead and Silver and Gold and Uranium.
2. The star dust is blown into space.

The photograph at right shows the remnants of a supernova seen by Chinese astronomers in the year 1054 AD. It is called the "Crab Nebula" and is in the constellation Taurus.



M1 – the Crab nebula.

The debris of a supernova explosion visible in daylight 1000 years ago.

New stars and… planets!

What happened before happens again – clouds coalesce to form stars, stars burn and create heavy elements and blow them into the cosmos, through stellar winds and, if the stars are big enough, supernova explosions. This cycle has happened many many times since the birth of the Universe.

When our Sun was born, about four thousand million years ago, so were the planets around it. Earth was born with an iron core, a silicon mantel, oceans and air full of oxygen and nitrogen, as well as small amounts of all the elements.

The silver and lead in the mines of Lavrion used to be stardust!

We are the children and the cousins of the stars.

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