

ASTRONOMY

Carbon in coal was created by stars billions of years ago

Tuesday, April 04, 2006

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Rt. 7 is a smog-drenched highway along the Ohio River that is home to foundries, chemical factories and one of Ohio's coal-fired power plants.

As I drove the stretch of road between Marietta and Athens last week, one factory caught my eye — Degussa Engineered Carbons.

The idea of engineering carbon seemed novel to me. A little research showed that Degussa synthesizes carbon compounds for use in plastics, lubricants and other industrial applications. Carbon itself is not synthesized in factories. With the exception of hydrogen and elements heavier than iron, all of the elements, including carbon, are synthesized deep inside stars.

Nucleosynthesis occurs near the center of stars where the weight acts like a piston that compresses the gas with a force of 300 trillion atmospheres. The pressure confines the hydrogen atoms to such a tight space that they heat up to millions of degrees and begin to fuse together to form helium and other heavier elements.

Nuclear fusion, the process driving nucleosynthesis, generates enough energy to maintain a star in a stable configuration and produces heat and starlight for billions of years.

Carbon is synthesized by a chain of nuclear reactions called the triple alpha process. It begins late in the life of a star after it has churned the hydrogen in its core into helium.

At that point, the star balloons into a giant, thousands of times its initial size. The 100-million-degree core of helium at its center is so dense, a teaspoonful would weigh as much as a truck. The helium nuclei, composed of two protons and two neutrons, then fuse together to form carbon atoms made of six protons and six neutrons.

The carbon atoms created by this process are ejected into space when the star dies. It mixes with other gas in our galaxy and gives birth to new stars and planets, which, like Earth, are rich in carbon.

The carbon atoms in coal were created in a star that lived 5 billion to 10 billion years before the sun formed. The energy released by burning coal comes from the chemical bonds between carbon atoms that were once locked in eons-old vegetation.

The energy in those bonds came from sunlight generated by nuclear reactions that occurred deep in the core of a younger sun.

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