ASTRONOMY

Life is a tricky balance of carbon and oxygen

Tuesday, November 18, 2008 3:03 AM

BY KENNETH HICKS

The chemistry of life on Earth depends on an abundant supply of carbon and oxygen. Astronomers have teamed up with nuclear physicists to find a critical balance in how these elements are produced inside stars.

Light elements, such as hydrogen and helium, were produced in the early years of the universe, just after the Big Bang. In contrast, carbon and oxygen were produced much later, from fusion reactions at the center of large stars, and jettisoned into space when these stars exploded (as supernovae).

The concept of fusion is fairly simple. Lighter elements, such as two hydrogen atoms, combine to form a single atom of deuterium. It's like taking two magnets and bringing them close enough so that they stick together.

The stuck-together magnet is like deuterium, made from the sum of two pieces. Next, two deuterium atoms can fuse together to form a single helium atom, and so on.

A potential problem arises when fusion reactions make carbon. This fusion could not take place without a special nuclear configuration of carbon (called the Hoyle state), such that a carbon atom can just barely absorb the fusion energy: no more, no less.

This nuclear property of carbon is crucial. In a paper published in the journal *Science*, the authors calculate that if the strong nuclear force were different by only 0.5 percent from its value found in nature, then the production of carbon and oxygen inside stars would be reduced by a factor of 30 and 1,000, respectively.

In other words, if the protons and neutrons didn't stick together quite as strongly, then stars would produce very little carbon and oxygen.

In the imaginary world where the "strength" of the nuclear force is only a half-percent different, then the lack of carbon and oxygen suggests that life on Earth would not exist. The balance of nature is truly awe-inspiring.

Kenneth Hicks is a professor of physics and astronomy at Ohio University in Athens.

hicks@ohio.edu
