Removing the pinhole

One of the reasons that researchers had not discovered this new form of matter being produced in the plasma focus was that their diagnostics were too small.

One major diagnostic system is just like the old pinhole camera, that is, it is a box with a small hole. The light, or radiation, or high-energy particle beams emanating from the plasma pinch, pass through the hole and impinge on a film. The picture when it is "developed" then provides a means for measuring the "what" and the "how much" of the light, radiation and/or high-energy particle beams that are recorded. (Various material filters and electric and magnetic fields can be combined with films of various materials to measure a particular form of beam.)

The problem with the atomic bubble superclusters was that they were bigger than the pinhole and would therefore "break up" before going through the pinhole. (Typically, these bubbles are from 100 to 200 microns in diameter.) Once the pinhole was significantly widened or removed, actual images of the atomic bubble superclusters were found by researchers.

Atomic bubble supercluster measurements

The superclusters are either formed within the pinch, or by the combination of the electron and ion beams emission of the pinch plasma. In any case the superclusters can be separated from the plasma focus pinch by sticking a glass tube near the pinch to permit a route along which the supercluster can travel.

The supercluster consists of millions of electrons and ions that are organized in the most unusual fashion. They form a spherical bubble with virtually all of the material being on the surface of the sphere. There are extremely high magnetic fields in the bubble—hundreds of megagauss in strength. The bubble is highly resilient and will bounce many times on the film before breaking up.

When the superclusters break up, the components come out with very high energies, like those found in a particle accelerator. Also the energy of the component electrons and ions is very coherent—monoenergetic. As a result of these measurements, it is found that the supercluster is acting like one big atom or "quantum" system. Furthermore, the density of the bubble surface is near that of solid materials.

The measured energy densities are quite high, and of the order needed to drive inertial fusion targets. Copious quantities of nuclear reactions are observed. Furthermore, more detailed nuclear reaction studies have observed significant numbers of heavy element nuclear fusion reactions—when these heavy elements are added to the hydrogen gas usually utilized in plasma focus discharges. These high rates of heavy element fusion reactions would not ordinarily be expected to take place in even the high-energy conditions found in the plasma focus pinch.

The supercluster bubbles are described as having a "negative temperature." This means that the supercluster will always transfer energy to matter with positive temperatures, no matter how high that temperature may be. Furthermore, this means that the supercluster bubble will not absorb electromagnetic radiation. (It is like the electromagnetic "shields" which are so often described in science fiction movies.) The bubbles are therefore negentropic relative to the observations of closed systems of ordinary matter-energy.

This "negative temperature" concept is often utilized in describing how lasers and superconductors work. In a superconductor we have "free electrons," like those in the plasma,

Nuclear studies endangered

Today, nuclear science is about to become extinct in the United States. With the virtual ban on nuclear teaching reactors located in or near universities, experimental nuclear studies have been reduced to a few locations. And these reduced sites are primarily utilizing high-energy particle accelerators. From the standpoint of making theoretical analysis of experiments most simple, the accelerator would appear to provide the path of least resistance for nuclear studies. But the path of least resistance is not always the most fruitful in terms of frontier research.

As these new plasma focus results indicate, significant advances can be obtained from what are not considered to be the most antiseptic circumstances determined by the existing theoretical overview. In fact, the accelerator-based nuclear research cannot access reactions with short-lived excited states. By combining creative theory with development of new diagnostics, it is possible to take a more "messy" experimental situation, like the plasma focus plasma pinch, and extract entirely new approaches.

The plasma focus offers an ideal platform for a wide range of advanced scientific research at all levels in a university. It is easy to build, cheap, and easy to run. The level of research is only limited by the insight of the operators. If plasma foci were to be proliferated throughout the institutions of higher learning in the U.S., it would be possible to generate a renaissance of physical science. But the institutional political investment in the existing, large "antiseptic" "pinhole" approach provided by particle accelerators seems to preclude this most promising alternative.