

The fact that the galaxies are moving away from each other necessarily means that they had to be closer to each other in the past. In fact, as we chronologically reverse the picture of the expanding universe, the galaxies come closer and closer together. We eventually come to a point where all the galaxies are compressed together in a space the size of a football field.

As we continue the compression process, we reach a point where all the untold billions of stars and planets in the Universe fit into a space the size of a milk bucket. The Universe then reaches a point of infinite density where matter and energy cease to exist. Space and time are no longer meaningful concepts. We are at the beginning of the Universe. Science can gather evidence no farther back. We are at the beginning!

The observations and proofs of the astronomers at last convinced the great Albert Einstein that the Universe had a beginning. That he held out for so long is often attributed to his personal discomfort with the implications of this conclusion. The odd thing is that it was Einstein's very equations that predicted an expanding universe. But Einstein had made a simple mathematical error that the renowned mathematician, Alexander Friedmann, had to correct. Even when Einstein finally acknowledged his own mathematical error, he was reluctant to admit its implications. In the end he bowed to the weight of both his own equations and the work of the Mount Wilson astronomers. He admitted the Universe had a beginning.

**The Depletion of Hydrogen.** Another important piece of evidence that the Universe had a beginning involved the chemical composition of stars. It was found that stars are composed mainly of hydrogen, the lightest element, which is consumed throughout the star's lifetime, creating other elements in the process. When the hydrogen is depleted, the star begins to die.

A few very large and massive stars end their lives by collapsing which in turn creates a catastrophic explosion. This exploding star is called a supernova and is responsible for converting lighter elements into the heavier elements of which planets such as Earth are composed. Once hydrogen has been burned within a star and converted to heavier elements, it does not return to its original state. This irreversible change, the constant decrease in the supply of fresh hydrogen in the Universe, indicates that the Universe is, in effect, being depleted of the chemical base for the composition of matter.

But discomfort persisted with the idea that the Universe had a beginning. In 1948, three British astronomers, Hermann Bondi,

FIGURE 1.4.

---

Einstein at the blackboard at the Mount Wilson Observatory in January 1931. The world-famous scientist and mathematician is shown writing the equation for the density of the Milky Way.

---

