

## A Matter of Perspective

LL 5/2/02

The Hubble Deep Field Photograph was taken in 1996. They say it covers an area in the sky approximately the size of a grain of sand held at arm's length. The size is actually a square 2.5 arc minutes on a side. 2.5 arc minutes is 0.04167 degrees. If we assume the arm's length is 36 inches then the sand grain would be  $\sin(0.04167) \times 36.0 = 0.026$  inches on a side. (2.5 arc minutes is 1/12 the apparent diameter of the Moon.)

The grain of sand covers appx. 0.00068 sq. in. The total surface area of a sphere with radius 36 inches is  $4 \times \pi \times (\text{radius})^2$  or 16286 sq. in. The ratio of the size of the sphere to the size of the grain of sand is 23,950,000 to 1. Actually a corner is cut out of the square of the HDF which reduces its size by 19% so the ratio is really 29,470,000 to 1.

The appx. number of galaxies visible in the Hubble Deep Field is said to be 3000. If we assume this is an image of average galactic densities then the number of galaxies in the Hubble Visible Universe (HVU) is appx. 90 billion.

Estimates of the number of stars in our own galaxy (Milky Way) range from 100 to 400 billion. If we take the more conservative figure and assume our galaxy is an average galaxy then there are appx. 9 X 10<sup>21</sup> stars in the HVU.

-----  
To bring these data into some kind of perspective, assume that a star is represented by that grain of sand we held at arm's length. The volume of that sand grain (if it is a cube) is 0.0000176 cubic in. If we pile up 100 billion of these grains of sand to represent the stars in the Milky Way, we end up with 1,758,000 cubic in. of sand, which is 1017 cubic ft. or a cube of sand 10 feet on a side. This represents about 1000 filled 5-gallon pails of sand which is a line of buckets about 3 football fields long. The number of stars we can see with our naked eye is about 6000 on the clearest nights. 6000 grains of sand would fit easily into a thimble.

If one average galaxy is equivalent to 1017 cubic feet of sand then 90 billion galaxies would fill 90 trillion cubic feet. This is a cube over 8 miles on a side. If we spread this into a layer of sand 10 feet deep, it would cover a square area of over 500 miles on a side which is roughly equivalent to the area of Texas (267,000 sq. mi.)

Put yet another way, if each galaxy were represented by a 10 foot cube of sand, and we placed these cubes next to each other in a straight line, the cubes representing all the galaxies in the HVU would extend for 170 million miles.

For approximate comparisons this line of sand cube would extend:

To the Sun and back almost once

To the Moon and back 350 times

Around the world 7,000 times

Toledo to Chicago and back 350,000 times

Toledo to Bowling Green and back 3,500,000 times

House to your average grocery store (1/4 mile away) and back 350,000,000 times

3,000,000,000 lengths of a football field

Laps of your house... you figure it out.