Human awareness of space and time

For pre-literate people, the world consisted of the things they could see. Anything too small to be seen with the naked eye was unimaginable; anything too distant to be seen within a day’s walk in effect did not exist. In time, anything too old to be part of communal memory was lost, unless marked by a monument. The world as understood by a preliterate person was thus a small one.
and gibbsite-producing reactions representative of drier and wetter climates, respectively, than those in which kaolinite forms. The list would be more thorough if the reactions for Fe-bearing minerals didn’t stop with Fe\(^2+\) as a product but showed Fe\(^2+\) then oxidized to an Fe\(^3+\)-bearing solid.

Milky Way Galaxy  
2.5 million LY  \(\times 10\) trillion km/LY = 2.5 quintillion km

\[
2.5 \times 10^6 \times 10^{13} = 2.5 \times 10^{19} \text{ km}
\]
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Human awareness of space and time

For literate pre-scientific people, the world was a little larger in space and time than that known to pre-literate people. Literate people could read about the recorded past (for example, a citizen of the European Renaissance could read about Classical Greece and Rome), and they could read about distant places and peoples (for example, that same European citizen could read Marco Polo’s account of travels to the Orient).
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In the past five hundred years, science has greatly expanded the space and time of which people can be aware. Astronomy has expanded our graph upward to great distances, microbiology and physics have expanded it downward to things far too small to be seen with naked eye, and geology has given an understanding of the distant past shown to the left off on our graph. The world understood by scientifically aware people is thus vastly larger than the world understood by people unfamiliar with science.
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The world of scientifically aware people (since about 1960)

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Some people remain pre-scientific today. They include pre-literate people who have no chance to know science, and they include literate people who refuse to accept the findings of science.
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**Human awareness of space and time**

The world of scientifically aware people
(since about 1960)

One result of this awareness is a change of perspective. We as individuals, and/or as the human collective, don’t seem quite so important, our troubles not so large, our needs not so great, when we are not one of few dozen people in a world a few miles wide but instead find ourselves in a world of many people, on a planet with a distant past, in a universe with a limitless future, and amidst planets and solar systems and galaxies out there beyond ourselves.

Milky Way Galaxy  2.5 million LY  x 10 trillion km/LY = 2.5 quintillion km

2.5x 10\(^6\)       x 10\(^{13}\)                 = 2.5 x 10\(^{19}\) km
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The world of scientifically aware people (since about 1960)

Distance

1 quintillion km ($10^{18}$ km)
1 quadrillion km
1 trillion km
1 light-year
1 billion km
1 million km
1000 km
1 km
1 mm
1 µm
1 nm
1 Angstrom

The world of space and time, and more

Time

1 billion years from now
1 million years from now
1000 years from now
1000 years ago
1 million years ago
1 billion years ago
1 trillion years ago
1000 years from now
1000 years ago
1 million years ago
1 billion years ago
1 quintillion km ($10^{18}$ km)
1 quadrillion km
1 trillion km
1 light-year
1 billion km
1 million km
1000 km
1 km
1 mm
1 µm
1 nm
1 Angstrom

We again clean up our slide to move onward with the next slide, which will again take things a bit further.

1000 years ago
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Distance to Andromeda Galaxy
Distance to Alpha Centauri, Sun's nearest neighbor
Distance to Moon
Earth's circumference
Radius of solar system
Distance to Sun
Distance to Andromeda Galaxy
Diameter of Milky Way Galaxy
Origin of Universe 1 billion years ago
Origin of Earth and Solar System
Dinosaurs 1 million years ago
Ice ages 1000 years ago
Origin of agriculture
Amoebae
Bacteria
Human awareness of space and time, and more
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One additional way that science has changed our view of the world around us is that matter exists both in ways that seem particle-like (as most of us know matter) and in ways that seem wave-like. Experiments have now demonstrated the wave properties of matter not only with regard to sub-atomic particles and atoms, but also with regard to molecules consisting of dozens of atoms.* Those experiments suggest that only the limitations of our laboratory equipment keep us from demonstrating the wave-particle duality of much larger entities.

Another way in which science has changed our awareness of the world around us is the equivalence of matter and energy. That relationship was expressed famously in the equation $E = mc^2$ and is demonstrated in our nuclear reactors and by our nuclear weapons.
Human awareness of space and time, and more

The world of scientifically aware people (since about 1960)

Another way in which science has changed our awareness of the world around us is the equivalence of matter and energy. That relationship was expressed famously in the equation $E = mc^2$ and is demonstrated in our nuclear reactors and by our nuclear weapons.

We may or may not, as William Blake would, “see a world in a grain of sand”, but we are now obliged to envision that grain of sand as a bundle of energy, as a wave as well as a particle, as a possible vestige of an ancient mountain range, or even as a possible micrometeorite that has brought us news of a world far beyond our own.