# Powers of Ten: About the Relative Size of Things in the Universe

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*Powers of Ten: About the Relative Size of Things in the Universe*
Philip and Phylis Morrison and the office of Charles and Ray Eames,
Scientific American Library: Distributors, W H Freeman and Company, 1982
pp. 150+Index, Price Rs. 350.

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A couple enjoying warm sunshine as they have a nap after a picnic in the park – a relatively common place event in our daily life. But making it as the centrepiece, this book takes the reader on two fantastic voyages – one through the larger and larger canvas ending in the largest known scale of structure in the universe, the other through the microworld of cells, molecules, atoms and sub-atomic particles.

This classic book by Philip and Phylis Morrison and the office of Charles and Ray Eames owes its genesis to an evolution of ideas and their translation in book and film forms. Charles Eames, an architect by profession used the successively growing exponential sequence as a tool towards estimating larger and larger as well as smaller and smaller scales. A film made in 1952 titled *A Communications Primer* used the idea of powers of ten to visualize large numbers. In 1961 one of the early mathematical peepshows introduced the binary system and the powers of two. Philip and Phylis Morrisons, perhaps the best known couple to the scientific community were inspired by the book *Cosmic View: The Universe in Forty Jumps* by Kees Bocke (a Dutch school teacher) into making the film *Powers of Ten* in collaboration with the Eameses. The present book is based on the film.

The reader is strongly advised to read the essay entitled 'Looking at the World' at the beginning, before delving into the main body of the text with its very attractive pictures. As the authors say here: "... The images finely perceived by eye and brain in a sense span the scientific knowledge of our times ... Behind every representation stands much more than can be imaged, including concepts of a subtle and often perplexing kind. Yet it is probably true that the linked conceptual structures of science are not more central to an overall understanding than the visual models we can prepare..."

The book itself is a sequence of stills from the movie. Each page has a picture drawn on a length scale ten times smaller than its predecessor. If you opened the book at the

beginning (following p. 19) you will be confronted with a square of side 25 powers of ten, (in metres) corresponding to the largest scale structure in the universe. I would not advise you to start here: rather start at the zero power, 25 pages further on, and proceed backwards till you reach the largest scale. Then return to the zero power and move forward along diminishing sizes.

Indeed the movie started this way and I wish the book followed that pattern. The scale of a metre is most familiar to us in everyday life. Human sizes typically range (for adults) well within one metre to two. The still shows the man stretched on the picnic rug. The next still now magnifies the scale by factor ten. The ten-metre square includes the picnicing couple and the surrounding lawn. For comparison a small central square reminds you of the extent of the preceding still. This practice continues all the way throughout the book. Thus we are gradually taken over to larger and larger scales all the way to where even groups of galaxies appear as tiny specks. The sequence can be followed towards smaller sizes next, starting again at one metre, all the way down to fifteen powers below it. This takes you to the interiors of protons, once thought of as the basic smallest structure of matter.

Perhaps it is a reminder that the contents of the book date back to the seventies: for today particle physicists routinely go down another fifteen powers and more adventurously to six more. The last frontier today stops at the so called quantum gravity limit where the concept of space and time and geometry that play key roles in Einstein's theory of relativity break down.

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It is awe-inspiring that compared to us humans this smallest frontier is further away on the scale of powers of ten than the largest one of the expanding universe. More awe-inspiring still to realize that we humans are applying the science we study in the labs spanning a few powers of ten around a metre to this entire range - *and are getting away with it*! Why should science have such universality? Why indeed is there such a thing as science apparently regulating micro to mega structures over some sixty powers of ten?

There is a considerable supplementary material in the final forty-odd pages on the march and span of science that may set the reader thinking along these lines. The authors are to be congratulated for presenting thought provoking material in a relatively small volume in an attractive way, and the publishers for doing justice to the effort in terms of quality of print and illustrations.

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