The great illusion in twilight zone



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WHILE TRAVELLING on a jet plane from London to Chicago, I was rewarded with a very unexpected sight. I saw the sun rise in the west. No, this was not a daydream but a real experience. The time was close to twilight hour when our jet was crossing Greenland, above the 60 degree latitude. The sun had just gone below the western horizon and most passengers were getting ready for a pre-dinner shut-eye... when it happened. I saw the sun reemerge into the sky from the west, where it had previously gone down. It continued rising for a short while and then sank again for a second sunset. Had the sun been momentarily confused as to which way to go?

The explanation was, in fact, simple. Normally, we see the sun rise in the east, move westwards and set in the west because we are observing it from the moving platform that is the earth. The earth spins from west to east. At high enough latitude a jet plane flying westwards surpasses the speed of the rotation of the earth, as it happened when my plane was flying over Greenland. While this happened, the sun appeared to move eastwards and was seen to rise above the western horizon. In fact, a supersonic jet like the erstwhile Concorde produced even more spectacular results: one could leave London at lunchtime and arrive in New York for breakfast, for the apparent motion of the sun was reversed! The aircraft could travel faster than the west-east motion of the earth's surface covering the path from London to New York.

This example cautions us that once we leave the terra firma we may be in for some strange sights. Take, for example, an astronaut circling the space in a satellite. He will see the sky above and around him as pitch black, despite the fact that the sun is shining with its full power! A photograph shows that the sun is seen as a glowing whitish disc, yet the space is dark as if the sun was unable to light it. Why? From down below, we see the sun shining through layers of dust and air molecules. The sunlight gets scattered by these particles and spreads across the sky, dominated by the violet-blue colours which are scattered the most. So we are accustomed to seeing a spread of blue sky. Up in space there are no such scatterers and the sky is lightless, i.e. black except, for the part where the solar disc shines.

The moon has no atmosphere, and it has no scattering agents like gas or dust. So, the sky here is black except where the sun is shining. The same holds for eclipses seen from the moon. The solar eclipse will happen when the earth comes between the moon and the sun. Since the earth is much larger than the moon, the solar eclipses on the moon are not as rare as they are on the earth. However, they are not so spectacular. For the sky, the moon is black even under normal circumstances, except where the solar disc shines. At the time of the eclipse only that shining disc will be covered.

And, finally, when we are on the moon, where will we see the earth in the sky? Like the moon from the earth, earth from the moon will be seen as a crescent. But that crescent will not move across the sky; it will stay put in one place! Sounds strange? But you will see the reason if you use the fact that as the moon orbits the earth it spins around its axis in such a way that it always presents the same face to the earth. You will also find that the earth gradually goes through phases like the moon while staying in the same place.

These are instances to warn us not to have a preconceived impression of the cosmos. By and large most of us expect the rest of the universe to be similar to what we know from our rather limited experience of viewing our neighbourhood. Over the years professional astronomers have learnt not to trust the maxim "seeing is believing". The image of an astronomical object may not necessarily correspond to reality. In short, there are enough optical illusions lying around to mislead the observer.

The hint of this possibility first came when Albert Einstein proposed his general theory of relativity. The theory clearly predicted that the path of a light ray skirting a massive body will "bend" because of the gravitational pull of that body. The bending of light from a star by the sun in this fashion was verified at the time of the total solar eclipse of 1919. At the time of eclipse the sun is fully covered and in the temporarily darkened sky one can see stars. The images of some of the stars whose light rays passed close to the sun were found to be slightly shifted.

Based on this finding, maverick astronomer Fritz Zwicky predicted in 1937 that there should be even more startling examples of bending of light by gravity. He expected these "gravitational lenses" to be found in the vast universe spread beyond our Milky Way Galaxy. Nobody took notice of his prediction, but in 1979 astronomers were to be reminded of it when they saw two identical-looking quasars in close proximity. Quasars look like stars but are in reality much more powerful sources of radiation. A typical quasar may radiate as much light as a galaxy of 100 billion stars. What were these two quasars?

As these quasars were very similar in appearance, the astronomers labelled them twin quasars. However, it became clear eventually that they were seeing "double", like a partygoer who has overindulged himself. The light rays from a single quasar were bent by an intervening galaxy in such a way that the rays got divided along two tracks, skirting the galaxy clockwise and anticlockwise, thereby producing two images of the same single source. In short, the intervening galaxy was acting like a gravitational lens. This was a sobering experience and was followed by several such examples of multiple imaging produced by gravitational lensing.

Isaac Newton, the originator of the law of gravitation, had conjectured that gravity affects light tracks. Einstein replied in the affirmative and nature has obliged with several supporting examples.

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