II. The Invisible Sphere and Maxwell’s Fisheye:

The Invisible Sphere and Maxwell’s Fisheye are special optical media in which Fermat’s Principle gives rise to light trajectories with loops.

- Light rays entering the Invisible Sphere (Fig. 4) emerge without their original direction altered, thus the Sphere becomes invisible.
- The Invisible Sphere on its own cannot make anything invisible, since its entire volume is accessible to light.
- In Maxwell’s Fisheye, light goes around in circles (Fig. 5).
- When a spherical mirror is introduced, the loops are still closed (Fig. 6).

Conclusion: The Invisible Sphere and Maxwell’s Fisheye make light propagate in loops.

- Below, we transformed a region of physical space (red region in Fig. 9) to a hidden virtual plane (red lower plane in Fig. 10 – see black arrow). We matched the colours to show which region maps to which.
- In both figures, light rays can cross from the blue to the red regions through the yellow branch cut (Fig. 9 & 10).
- In Fig. 10, the upper sheet is visible and the Underworld – although hidden – is accessible through the yellow branch cut, just as the hidden inside of Dr Who’s Tardis is accessible through its door.

An Invisibility Device

We can now put the above ideas together to construct an invisibility device!

- On the visible upper sheet of Fig. 11, we implement the Invisible Sphere and Maxwell’s Fisheye with the mirror.
- In Fig. 12, we reverse the coordinate transformations and obtain the trajectories and the position of the mirror in physical space. This physical medium can be engineered into metamaterials.
- The numbers in Figs. 11 & 12 explain the path of light in virtual and physical space respectively. The light ray…

Conclusion: A finite region of physical space can be expanded into a hidden virtual space.

- In Fig. 11, the Underworld outside the green mirror is inaccessible to light. It transforms to a physical region bounded by a spindle-shaped mirror in Fig. 12. Objects placed in this region are made invisible!

References:

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